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DTC PROJECT NO. 8-CO-160-UXO-021
REPORT NO. ATC-8755

STANDARDIZED

UXO TECHNOLOGY DEMONSTRATION SITE

OPEN FIELD SCORING RECORD NO. 129

SITE LOCATION:
U.S. ABERDEEN PROVING GROUND

DEMONSTRATOR:
GEOPHEX, LTD.
605 MERCURY ST.
RALEIGH, NC 27603-2343

TECHNOLOGY TYPE/PLATFORM:
GEM-3 EMI/PUSHCART AND TOWED

PREPARED BY:
U.S. ARMY ABERDEEN TEST CENTER
ABERDEEN PROVING GROUND, MD 21005-5059

NOVEMBER 2004

Prepared for:
U.S. ARMY ENVIRONMENTAL CENTER
ABERDEEN PROVING GROUND, MD 21010-5401

U.S. ARMY DEVELOPMENTAL TEST COMMAND
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14. ABSTRACT
This scoring record documents the efforts of Geophex, LTD to detect and discriminate inert unexploded ordnance (UXO) utilizing the APG Standardized UXO Technology Demonstration Site Open Field. The scoring record was coordinated by Larry Overbay and by the Standardized UXO Technology Demonstration Site Site Scoring Committee. Organizations on the committee include the U.S. Army Corps of Engineers, the Environmental Security Technology Certification Program, the Strategic Environmental Research and Development Program, the Institute for Defense Analysis, the U.S. Amry Environmental Center, and the U.S. Army Aberdeen Test Center.

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SECTION 1. GENERAL INFORMATION

1.1 BACKGROUND

Technologies under development for the detection and discrimination of unexploded ordnance (UXO) require testing so that their performance can be characterized. To that end, Standardized Test Sites have been developed at Aberdeen Proving Ground (APG), Maryland and U.S. Army Yuma Proving Ground (YPG), Arizona. These test sites provide a diversity of geology, climate, terrain, and weather as well as diversity in ordnance and clutter. Testing at these sites is independently administered and analyzed by the government for the purposes of characterizing technologies, tracking performance with system development, comparing performance of different systems, and comparing performance in different environments.

The Standardized UXO Technology Demonstration Site Program is a multi-agency program spearheaded by the U.S. Army Environmental Center (AEC). The U.S. Army Aberdeen Test Center (ATC) and the U.S. Army Corps of Engineers Engineering Research and Development Center (ERDC) provide programmatic support. The program is being funded and supported by the Environmental Security Technology Certification Program (ESTCP), the Strategic Environmental Research and Development Program (SERDP) and the Army Environmental Quality Technology Program (EQT).

1.2 SCORING OBJECTIVES

The objective in the Standardized UXO Technology Demonstration Site Program is to evaluate the detection and discrimination capabilities of a given technology under various field and soil conditions. Inert munitions and clutter items are positioned in various orientations and depths in the ground.

The evaluation objectives are as follows:

a. To determine detection and discrimination effectiveness under realistic scenarios that vary targets, geology, clutter, topography, and vegetation.

b. To determine cost, time, and manpower requirements to operate the technology.

c. To determine demonstrator's ability to analyze survey data in a timely manner and provide prioritized "Target Lists" with associated confidence levels.

d. To provide independent site management to enable the collection of high quality, ground-truth, geo-referenced data for post-demonstration analysis.

1.2.1 Scoring Methodology

a. The scoring of the demonstrator's performance is conducted in two stages. These two stages are termed the RESPONSE STAGE and DISCRIMINATION STAGE. For both stages, the probability of detection (P_d) and the false alarms are reported as receiver-operating characteristic (ROC) curves. False alarms are divided into those anomalies that correspond to emplaced clutter items, measuring the probability of false positive (P_{fp}), and those that do not correspond to any known item, termed background alarms.

b. The RESPONSE STAGE scoring evaluates the ability of the system to detect emplaced targets without regard to ability to discriminate ordnance from other anomalies. For the open field RESPONSE STAGE, the demonstrator provides the scoring committee with the field location and signal strength of all anomalies that the demonstrator has deemed sufficient to warrant further investigation and/or processing as potential emplaced ordnance items. This list is generated with minimal processing and will only include signals that are above the system noise level.

c. The DISCRIMINATION STAGE evaluates the demonstrator's ability to correctly identify ordnance as such and to reject clutter. For the same field locations as in the RESPONSE STAGE anomaly list, the DISCRIMINATION STAGE list contains the output of the algorithms applied in the discrimination-stage processing. This list is prioritized based on the demonstrator's determination that an anomaly location is likely to contain ordnance. Thus, higher output values are indicative of higher confidence that an ordnance item is present at the specified location. For digital signal processing, priority ranking is based on algorithm output. For other discrimination approaches, priority ranking is based on human (subjective) judgment. The demonstrator also specifies the threshold in the prioritized ranking that provides optimum performance termed the Discrimination Stage Threshold (i.e. that is expected to retain all detected ordnance and reject the maximum amount of clutter).

d. The demonstrator is also scored on EFFICIENCY and REJECTION RATIO, which measure the effectiveness of the discrimination stage processing. The goal of discrimination is to retain the greatest number of ordnance detections from the anomaly list, while rejecting the maximum number of anomalies arising from non-ordnance items. EFFICIENCY measures the fraction of detected ordnance retained after discrimination, while the REJECTION RATIO measures the fraction of false alarms rejected. Both measures are defined relative to the entire response stage anomaly list, i.e., the maximum ordnance detectable by the sensor and its accompanying false positive rate or background alarm rate.

e. Based on configuration of the ground truth at the standardized sites and the defined scoring methodology, there exists the possibility of having anomalies within overlapping halos and/or multiple anomalies within halos. In these cases, the following scoring logic is implemented:

(1) In situations where multiple anomalies exist within a single R_{halo}, the anomaly with the strongest response or highest ranking will be assigned to that particular ground truth item.

(2) For overlapping R_{halo} situations, ordnance has precedence over clutter. The Anomaly with the strongest response or highest ranking that is closest to the center of a particular ground truth item gets assigned to that item. Remaining anomalies are retained until all matching is complete.

(3) Anomalies located within any R_{halo} that do not get associated with a particular ground truth item are thrown out and are not considered in the analysis.

f. All scoring factors are generated utilizing the Standardized UXO Probability and Plot Program, version 3.1.1.

1.2.2 Scoring Factors

Factors to be measured and evaluated as part of this demonstration include:

a. Response Stage ROC curves:

(1) Probability of Detection (P_d^{res}).

(2) Probability of False Positive (P_{fp}^{res}).

(3) Background Alarm Rate (BAR^{res}) or Probability of Background Alarm (P_{BA}^{res}).

b. Discrimination Stage ROC curves:

(1) Probability of Detection (P_d^{disc}).

(2) Probability of False Positive (P_{fp}^{disc}).

(3) Background Alarm Rate (BAR^{disc}) or Probability of Background Alarm (P_{BA}^{disc}).

c. Metrics:

(1) Efficiency (E).

(2) False Positive Rejection Rate (R_{fp}).

(3) Background Alarm Rejection Rate (R_{BA}).

d. Other:

(1) Probability of Detection by Size and Depth.

(2) Classification by type (i.e., 20-, 40-, 105-mm, etc.).

(3) Location accuracy.

(4) Equipment setup, calibration time and corresponding man-hour requirements.

(5) Survey time and corresponding man-hour requirements.

(6) Reacquisition/resurvey time and man-hour requirements (if any).

(7) Downtime due to system malfunctions and maintenance requirements.

1.3 STANDARD AND NONSTANDARD INERT ORDNANCE TARGETS

The standard and nonstandard ordnance items emplaced in the test areas are listed in Table 1. Standardized targets are members of a set of specific ordnance items that have identical properties to all other items in the set (caliber, configuration, size, weight, aspect ratio, material, filler, magnetic remanence, and nomenclature). Nonstandard targets are inert ordnance items having properties that differ from those in the set of standardized targets.

TABLE 1. INERT ORDNANCE TARGETS

Standard Type	Nonstandard (NS)
20-mm Projectile M55	20-mm Projectile M55
	20-mm Projectile M97
40-mm Grenades M385	40-mm Grenades M385
40-mm Projectile MKII Bodies	40-mm Projectile M813
BDU-28 Submunition	
BLU-26 Submunition	
M42 Submunition	
57-mm Projectile APC M86	
60-mm Mortar M49A3	60-mm Mortar (JPG)
	60-mm Mortar M49
2.75-inch Rocket M230	2.75-inch Rocket M230
	2.75-inch Rocket XM229
MK 118 ROCKEYE	
81-mm Mortar M374	81-mm Mortar (JPG)
	81-mm Mortar M374
105-mm Heat Rounds M456	
105-mm Projectile M60	105-mm Projectile M60
155-mm Projectile M483A1	155-mm Projectile M483A
	500-lb Bomb

JPG = Jefferson Proving Ground

SECTION 2. DEMONSTRATION

2.1 DEMONSTRATOR INFORMATION

2.1.1 Demonstrator Point of Contact (POC) and Address

Point of contact: Bill SanFilipo
(919) 839-8515

Address: Geophex, Ltd.
605 Mercury Street
Raleigh, NC 27603-2343

2.1.2 System Description (provided by demonstrator)

GEM-3 Electromagnetic Induction (EMI) sensors are multi-frequency (up to 10 frequencies logarithmically spaced in the 30 Hz to 47930 Hz range) sensors consisting of three concentric coils and digital electronics. The outer coil is the primary transmitter, the inner coil the receiver, and the annular coil is a secondary (bucking) transmitter that creates a primary field cavity around the transmitter. The electronics includes a digitally controlled switching H-bridge transmitter current-source, a 24 bit analog to digital (A/D), and a Digital Signal Processor (DSP) with random access memory (RAM) and flash memory and serial data ports (RS-232). A user interface consists of a palm pack computer with Geophex software; commercial digital Global Positioning System (DGPS) is fully integrated.

The system is a continuous wave frequency domain system in which data are recorded while the transmitter is on; the transmitter waveform consists of a continuous mix of superposed sine waves at the specified frequencies. The measured raw time-series data are voltages (pre-amplified) measured by the receiver coil and by a small reference coil located in the transmitter primary/bucking coil annular space (proportional to primary field and phase referenced to primary field), and sampled by the A/D. Data are pre-processed in units of 30-Hz intervals (base periods) and averaged over a selectable number of base periods, typically two for cart-survey operation (net output rate of 15 Hz).

The cart-mounted configuration, with a 96-cm diameter coil disk mounted on either a manually pushed composite material wheeled cart or an all terrain vehicle (ATV) towed wooden wheeled cart, is used in environments where a large sensor on a wheeled cart is practical and wide-area coverage required, such as flat, open terrain (fig.1). The ATV towed system is augmented with a navigation system that provides the driver with steering indicators in order to maintain preplanned survey lines, but it requires greater room for turning than the hand pushed (fig. 2) cart. The actual sensors are identical and can be interchanged. A DGPS system is integrated with the GEM console, and the antenna mounted directly above the sensor, provides geo-referenced data, which are recorded in the GEM console flash memory and/or the system (laptop PC) computer. Data are post-processed for target detection/classification.

Figure 1. GEM-3 EMI pushcart demonstrator's system.

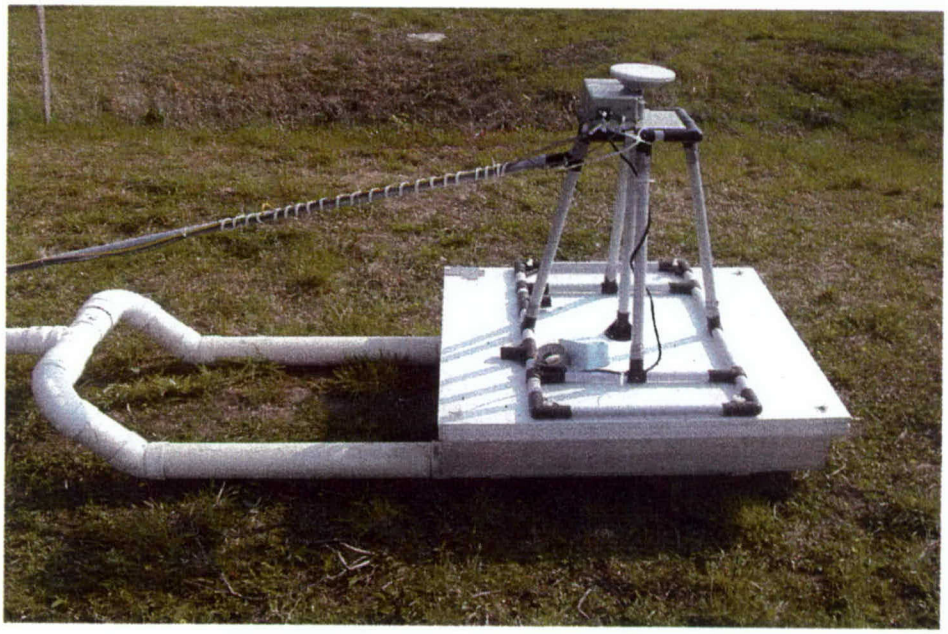

Figure 2. GEM-3 EMI towed demonstrator's system.

2.1.3 Data Processing Description (provided by demonstrator)

The front-end data processing is performed in real-time by the system DSP. This processing consists of performing a partial Digital Fourier Transform (DFT) on the receiver and reference time series provided by the A/D at 96 kHz. The DFT frequency samples correspond to the logarithmically spaced transmitted frequencies characterizing the hybrid current waveform. Complex division of the receiver and reference DFT outputs are performed, and system transfer function (calibration) corrections are applied, to generate inphase and quadrature measurements at each frequency. These data are recorded in the console flash memory and/or output to the system computer.

Further processing, performed during post-processing, consists of color-contour map generation using commercial software such as Geosoft©. Target detection utilizes either a composite measurement such as the sum of the quadratures over all frequencies, or a weighted average apparent conductivity over all frequencies. Anomalies identified from the maps may be further scrutinized in profile format. For target discrimination, a spectral matching algorithm compares the measurement with a library of known possible target spectra; this algorithm allows for a linear combination of the intrinsic longitudinal and transverse target response. The quality of the best fit (i.e. rms or mean absolute error) is compared with a threshold for clutter declaration and used as a confidence measure.

The survey method in the calibration and blind grids will be applied by occupying the potential target location points, preceded with a nearby background reading or (optionally) utilizing a continuous filtered background reading, and operator initiated data sampling/storing for two seconds. Target locations will be identified in the data files via line numbers. The raw data will be post-processed as described above.

In the open area, the cart will be towed with an ATV at walking speed along half-meter spaced lines; these lines will be maintained using the onboard navigation system based on DGPS. The console and downloading software, as well as the system computer logging the data, perform geo-referencing of the GEM data automatically. The GEM and Global Positioning System (GPS) data will be post-processed to provide geo-referenced dig lists as described above. The cart will be manually pushed, as needed, where maneuvering the ATV is difficult and in small patches that extend outside the main area.

2.1.4 Data Submission Format

Data was submitted for scoring in accordance with data submission protocols outlined in the Standardized UXO Technology Demonstration Site Handbook (app E, ref 1). This data is not included in this report in order to protect ground truth information.

2.1.5 Demonstrator Quality Assurance (QA) and Quality Control (QC) (provided by demonstrator)

QC will be performed by testing the systems with a test target (ferrite) each day, and verifying proper and consistent system measurements. QA will include a review of recorded data at the end of each day.

2.1.6 Additional Records

The following record(s) of this demonstrator's field activities can be accessed via the Internet as Word files at www.uxotestsites.org.

Geophex Blind Grid Scoring Record No. 49, dated October 2003. Record is published.
Geophex Blind Grid Scoring Record No. 50, dated October 2003. Record is published.
Geophex Blind Grid Scoring Record No. 125, dated January 2004. Record is published.

2.2 APG SITE INFORMATION

2.2.1 Location

The APG Standardized Test Site is located within a secured range area of the Aberdeen Area. The Aberdeen Area of APG is located approximately 30 miles northeast of Baltimore at the northern end of the Chesapeake Bay. The Standardized Test Site encompasses 17 acres of upland and lowland flats, woods and wetlands.

2.2.2 Soil Type

According to the soils survey conducted for the entire area of APG in 1998, the test site consists primarily of Elkton Series type soil (ref 2). The Elkton Series consist of very deep, slowly permeable, poorly drained soils. These soils formed in silty aeolin sediments and the underlying loamy alluvial and marine sediments. They are on upland and lowland flats and in depressions of the Mid-Atlantic Coastal Plain. Slopes range from 0 to 2 percent.

ERDC conducted a site-specific analysis in May of 2002 (ref 3). The results basically matched the soil survey mentioned above. Seventy percent of the samples taken were classified as silty loam. The majority (77 percent) of the soil samples had a measured water content between 15- and 30-percent with the water content decreasing slightly with depth.

For more details concerning the soil properties at the APG test site, go to www.uxotestsites.org on the web to view the entire soils description report.

2.2.3 Test Areas

A description of the test site areas at APG is included in Table 2.

TABLE 2. TEST SITE AREAS

Area	Description
Calibration Grid	Contains 14 standard ordnance items buried in six positions at various angles and depths to allow demonstrator to calibrate their equipment.
Blind Test Grid	Contains 400 grid cells in a 0.2-hectare (0.5 acre) site. The center of each grid cell contains ordnance, clutter or nothing.
Open Field	A 4-hectare (10-acre) site containing open areas, dips, ruts and obstructions that challenge platform systems or hand held detectors. The challenges include a gravel road, wet areas and trees. The vegetation height varies from 15 to 25 cm.

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SECTION 3. FIELD DATA

3.1 DATE OF FIELD ACTIVITIES (28 April through 7 May 2003)

3.2 AREAS TESTED/NUMBER OF HOURS

Areas tested and number of hours operated at each site are summarized in Table 3.

TABLE 3. AREAS TESTED AND NUMBER OF HOURS

Area	Number of Hours
Calibration Lanes	2.93
Blind Test Grid	See section 3.8
Open Field	120.88

3.3 TEST CONDITIONS

3.3.1 Weather Conditions

An ATC weather station located approximately 2 miles west of the test site was used to record average temperature and precipitation on an hourly basis for each day of operation. The temperatures listed in Table 4 represent the average temperature during field operations from 0700 through 1700 hours while the precipitation data represents a daily total amount of rainfall. Hourly weather logs used to generate this summary are provided in Appendix B.

TABLE 4. TEMPERATURE/PRECIPITATION DATA SUMMARY

Date, 2003	Average Temperature, °F	Total Daily Precipitation, in.
28 April	71.55	0.00
29 April	71.49	0.00
30 April	67.62	0.00
1 May	71.11	0.05
2 May	78.35	0.00
3 May	65.32	0.00
4 May	62.76	0.00
5 May	53.09	0.03
6 May	57.36	0.02
7 May	69.85	0.56

3.3.2 Field Conditions

Geophex surveyed the open field area with the GEM-3 towed configuration 1 May through 3 May, and 5 May through 7 May. The GEM-3 pushcart surveyed the open field area from 29 April to 2 May and 6 through 7 May. The open field was extremely muddy due to prior rain events before testing.

3.3.3 Soil Moisture

Five soil probes were placed at various locations of the site to capture soil moisture data: wet, wooded, open, areas, calibration lanes, and blind grid/moguls. Measurements were collected in percent moisture and were taken twice daily (morning and afternoon) from five different soil layers (0 to 6 in., 6 to 12 in., 12 to 24 in., 24 to 36 in., and 36 to 48 in.) from each probe. Soil moisture logs are included in Appendix C.

3.4 FIELD ACTIVITIES

3.4.1 Setup/Mobilization

These activities included initial mobilization and daily equipment preparation and breakdown. A crew of 4 people took 2 hours and 56 minutes to perform the initial setup and mobilization. Daily equipment preparation took a total of 18 hours and 2 minutes while end of day equipment breakdown lasted a total of 4 hours and 55 minutes. Daily start/stop activities totaled 1 hour 2 minutes for the open field. These recordings include the amount of time it took to initially mobilize, prepare and breakdown for both the towed array and the pushcart GEM-3 systems.

3.4.2 Calibration

The demonstrator spent 2 hours and 56 minutes in the calibration lanes on 28 April 2003 using the Pushcart mounted GEM-3. No other calibration activities were conducted while operating in the open field.

3.4.3 Downtime Occasions

Occasions of downtime are grouped into five categories: equipment/data checks or equipment maintenance, equipment failure and repair, weather, Demonstration Site issues, or breaks/lunch. All downtime is included for the purposes of calculating labor costs (section 5) except for downtime due to Demonstration Site issues. Demonstration Site issues, while noted in the Daily Log, are considered non-chargeable downtime for the purposes of calculating labor costs and are not discussed. Breaks and lunches are not discussed either.

3.4.3.1 Equipment/data checks, maintenance. Equipment/data checks and maintenance activities accounted for 10 hours and 48 minutes of site usage time. These activities included changing out batteries and routine data checks and downloading data to ensure it was being properly recorded/collected.

3.4.3.2 Equipment failure or repair. Four equipment failures occurred in the open field. The GPS Console had to be replaced because of a broken pin. The GPS console from the pushcart was installed on the towed cart. Also, a bad cable connection was found from the laptop panel to sensor being towed. It had to be sodered. The third failure was the GPS system was not working for Geophex for a short period of time. Geophex also had software issues that had to be resolved before the towed array system was operational. The total downtime because of equipment failures was 34 hours and 29 minutes.

3.4.3.3 Weather. Two weather delays occurred in the open field. Both occurred on May 5th. One delay lasted 11 minutes while the other lasted 1-hour and 5 minutes.

3.4.4 Data Collection

The demonstrator spent 47 hours and 23 minutes collecting data with the towed and the pushcart GEM-3 in the open field. This time excludes break/lunches and downtimes described in section 3.4.3.

3.4.5 Demobilization

A crew of two people took 1 hour and 7 minutes to breakdown and pack up equipment for demobilization.

3.5 PROCESSING TIME

Geophex submitted the raw data from demonstration activities on the last day of the demonstration, as required. The scoring submission data was also provided within the required 30-day timeframe.

3.6 DEMONSTRATOR'S FIELD PERSONNEL

Supervisor:	Bill SanFilipo, Geophysicist
Data Analyst:	Mike Shipman, Software Engineer
Field Survey:	Todd Majors, Geoscientist
Field Survey:	Dak Darbha, Data processing Geophysicist
Field Survey:	John Gregory Schuster, Field Geoscientist
Field Survey:	Colin Lanford, Field Geoscientist

3.7 DEMONSTRATOR'S FIELD SURVEYING METHOD

Geophex surveyed the open field with the towed array in a circular fashion, starting in the middle of the site and circled their way out to the outer edge. Geophex used the pushcart to catch any areas it would have been tough to the maneuver the towed vehicle in and out of. The pushcart surveyed the open field in a linear fashion.

3.8 SUMMARY OF DAILY LOGS

Daily logs capture all field activities during this demonstration and are located in Appendix D. Activities pertinent to this specific demonstration are indicated in highlighted text.

Four significant problems occurred in the open field: 1) pin breaking in the GPS console. The GPS console was replaced using the one that was on the pushcart system; 2) bad cable connection was found from the laptop panel to sensor being towed. It had to be sodered; 3) GPS system was not working for Geophex for a short period of time due to satellite problems; 4) Geophex had software problems that to be resolved before the towed vehicle was operational. It was estimated that 25 percent of the open field was covered by the pushcart and 75 percent by the towed vehicle. The Blind grid area was surveyed by both pushcart and towed vehicle. For information on the Blind Grid please visit our website at www.uxotestsites.org.

SECTION 4. TECHNICAL PERFORMANCE RESULTS

4.1 ROC CURVES USING ALL ORDNANCE CATEGORIES

Figure 3 shows the probability of detection for the response stage (P_d^{res}) and the discrimination stage (P_d^{disc}) versus their respective P_{fp}. Figure 4 shows both probabilities plotted against their respective BAR. Both figures use a horizontal line to illustrate the performance of the demonstrator at the demonstrator's recommended discrimination stage threshold level, which defines the subset of targets the demonstrator would recommend digging based on discrimination. Note that all points have been rounded to protect the ground truth.

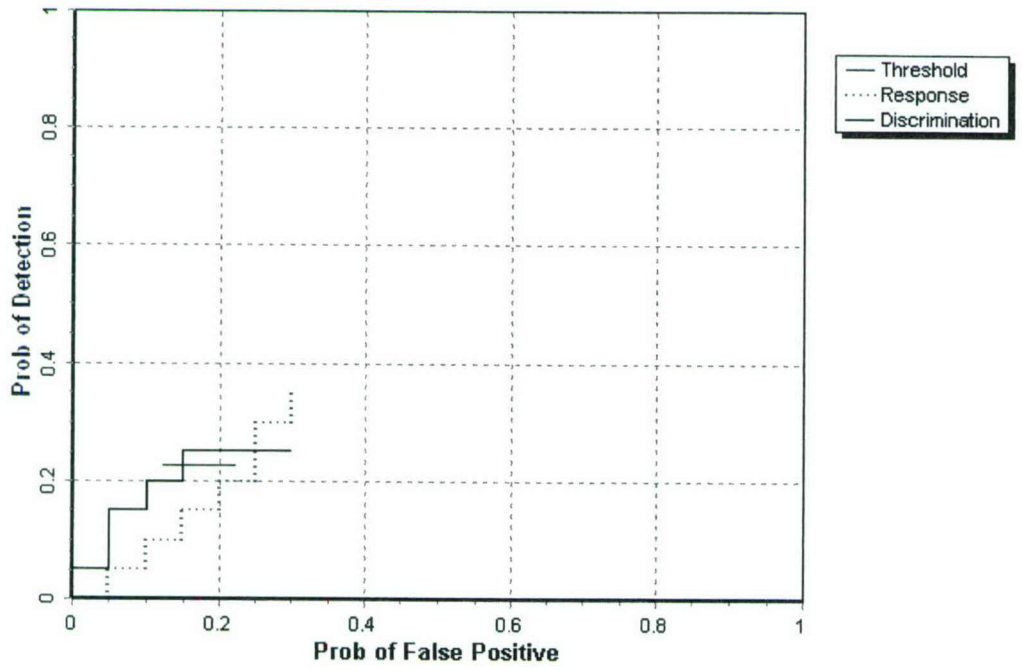

Figure 3. GEM-3 open field probability of detection for response and discrimination stages versus their respective over all ordnance categories combined.

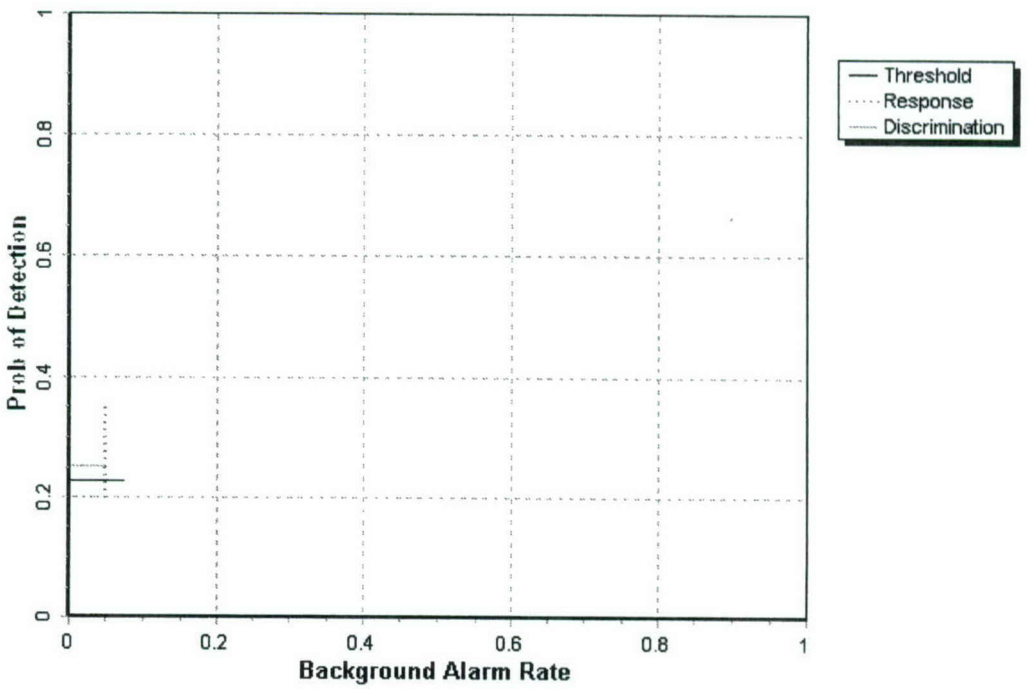

Figure 4. GEM-3 open field probability of detection for response and discrimination stages versus their respective BAR over all ordnance categories combined.

4.2 ROC CURVES USING ORDNANCE LARGER THAN 20 MM

Figure 5 shows the probability of detection for the response stage (P_d^{res}) and the discrimination stage (P_d^{disc}) versus their respective P_{fp} when only targets larger than 20 mm are scored. Figure 6 shows both probabilities plotted against their respective BAR. Both figures use a horizontal line to illustrate the performance of the demonstrator at the demonstrator's recommended discrimination stage threshold level, which defines the subset of targets the demonstrator would recommend digging based on discrimination. Note that all points have been rounded to protect the ground truth.

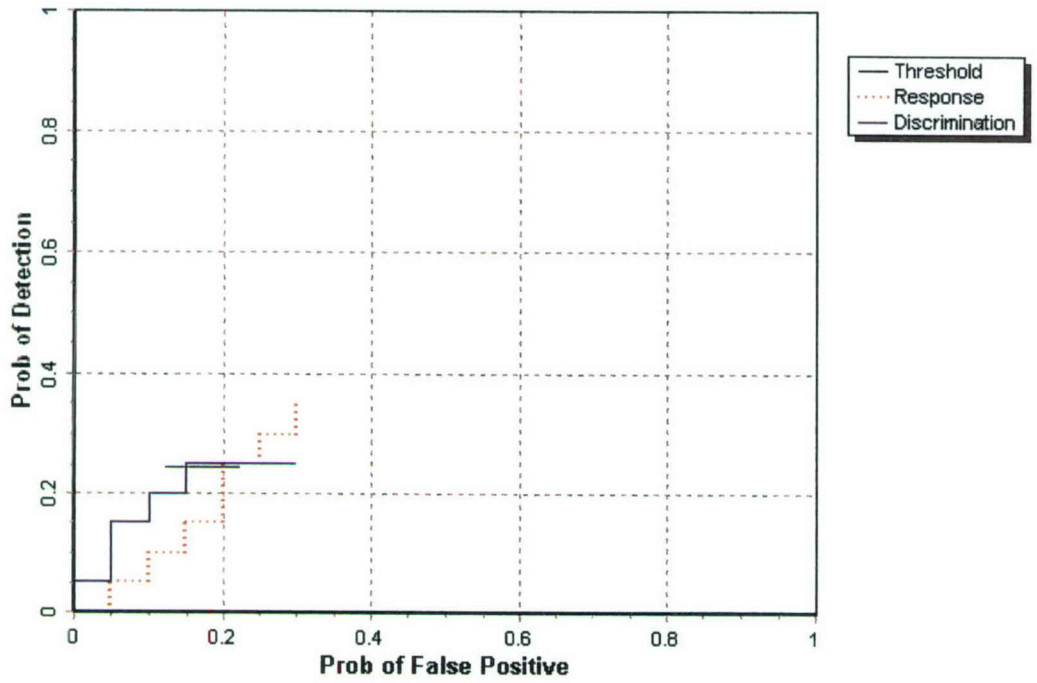

Figure 5. GEM-3 open field probability of detection for response and discrimination stages versus their respective P_{fp} for all ordnance larger than 20 mm.

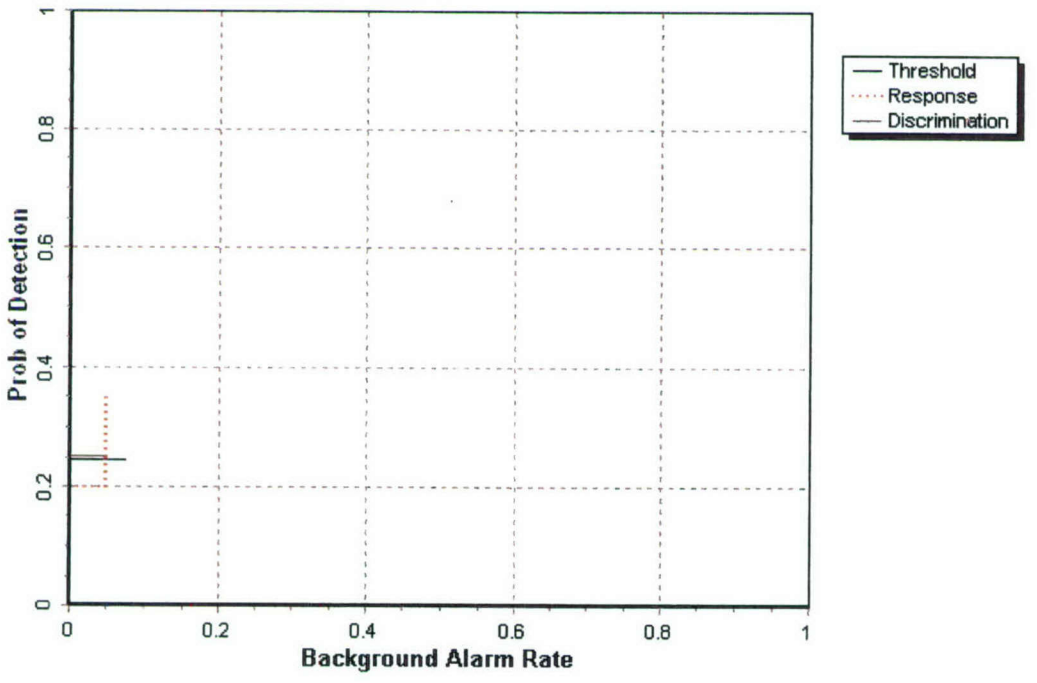

Figure 6. GEM-3 open field probability of detection for response and discrimination stages versus their respective background alarm rate for all ordnance larger than 20 mm.

4.3 PERFORMANCE SUMMARIES

Results for the Open field test broken out by size, depth and nonstandard ordnance are presented in Table 5. (For cost results, see section 5.) Results by size and depth include both standard and nonstandard ordnance. The results by size show how well the demonstrator did at detecting/discriminating ordnance of a certain caliber range. (See app A for size definitions.) The results are relative to the number of ordnance items emplaced. Depth is measured from the geometric center of anomalies.

The RESPONSE STAGE results are derived from the list of anomalies above the demonstrator-provided noise level. The results for the DISCRIMINATION STAGE are derived from the demonstrator's recommended threshold for optimizing UXO field cleanup by minimizing false digs and maximizing ordnance recovery. The lower 90-percent confidence limit on probability of detection and P_{fp} was calculated assuming that the number of detections and false positives are binomially distributed random variables. All results in Table 5 have been rounded to protect the ground truth. However, lower confidence limits were calculated using actual results.

TABLE 5. SUMMARY OF OPEN FIELD RESULTS FOR GEM-3 EMI

				By Size			By Depth, m		
Metric	**Overall**	**Standard**	**Non-Standard**	**Small**	**Medium**	**Large**	**< 0.3**	**0.3 to <1**	**>= 1**
RESPONSE STAGE									
P_d	0.35	0.35	0.30	0.25	0.35	0.40	0.45	0.30	0.05
P_d Low 90% Conf	0.30	0.30	0.26	0.21	0.31	0.33	0.39	0.27	0.03
P_{fp}	0.30	--	--	-	-	-	0.30	0.30	0.30
P_{fp} Low 90% Conf	0.29	--	--	-	-	-	0.28	0.28	0.16
BAR	0.05	--	--	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	0.25	0.20	0.25	0.15	0.35	0.20	0.30	0.20	0.05
P_d Low 90% Conf	0.20	0.18	0.19	0.11	0.28	0.13	0.27	0.16	0.01
P_{fp}	0.15	--	--	-	-	-	0.20	0.15	0.15
P_{fp} Low 90% Conf	0.16	--	--	-	-	-	0.16	0.15	0.03
BAR	0.00	--	--	-	-	-	-	-	-

Recommended Discrimination Stage Threshold: 4.5.

Note: The recommended discrimination stage threshold values are provided by the demonstrator.

4.4 EFFICIENCY, REJECTION RATES, AND TYPE CLASSIFICATION

Discrimination data was not required for this particular demonstration. Therefore, no results will be presented for this section.

4.5 LOCATION ACCURACY

Discrimination data was not required for this particular demonstration. Therefore, no results will be presented for this section.

TABLE 6. MEAN LOCATION ERROR AND STANDARD DEVIATION (M)

No data available.

(Page 20 Blank)

SECTION 5. ON-SITE LABOR COSTS

A standardized estimate for labor costs associated with this effort was calculated as follows: the first person at the test site was designated "supervisor", the second person was designated "data analyst", and the third and following personnel were considered "field support". Standardized hourly labor rates were charged by title: supervisor at $95.00/hour, data analyst at $57.00/hour, and field support at $28.50/hour.

Government representatives monitored on-site activity. All on site activities were grouped into one of ten categories: initial setup/mobilization, daily setup/stop, calibration, collecting data, downtime due to break/lunch, downtime due to equipment failure, downtime due to equipment/data checks or maintenance, downtime due to weather, downtime due to demonstration site issue, or demobilization. See Appendix D for the daily activity log. See section 3.4 for a summary of field activities.

The standardized cost estimate associated with the labor needed to perform the field activities is presented in Table 7. Note that calibration time includes time spent in the Calibration Lanes as well as field calibrations. "Site survey time" includes daily setup/stop time, collecting data, breaks/lunch, downtime due to equipment/data checks or maintenance, downtime due to failure, and downtime due to weather.

TABLE 7. ON-SITE LABOR COSTS

	No. People	Hourly Wage	Hours	Cost
INITIAL SETUP				
Supervisor	1	$95.00	3.58	340.10
Data Analyst	1	57.00	3.58	204.06
Field Support	2	28.50	3.58	204.06
Subtotal				**$748.22**
CALIBRATION				
Supervisor	1	$95.00	2.93	278.35
Data Analyst	0	57.00	0.00	0.00
Field Support	0	28.50	0.00	0.00
Subtotal				**$278.35**
SITE SURVEY				
Supervisor	1	$95.00	120.88	11483.60
Data Analyst	1	57.00	120.88	6890.16
Field Support	4	28.50	120.88	13780.32
Subtotal				**$32154.08**

See notes at end of table.

TABLE 7 (CONT'D)

	No. People	Hourly Wage	Hours	Cost
DEMOBILIZATION				
Supervisor	1	$95.00	1.12	106.40
Data Analyst	1	57.00	1.12	63.84
Field Support	0	28.50	0.00	0.00
Subtotal				**$170.24**
Total				**$33350.89**

Notes: Calibration time includes time spent in the Calibration Lanes as well as calibration before each data run.

Site Survey time includes daily setup/stop time, collecting data, breaks/lunch, downtime due to system maintenance, failure, and weather.

SECTION 6. COMPARISON OF RESULTS TO BLIND GRID DEMONSTRATION

6.1 SUMMARY OF RESULTS FROM BLIND GRID DEMONSTRATION

Table 8 shows the results from Blind Grid survey conducted prior to surveying the open field during the same site visit in August of 2003. For more details on the Blind Grid survey results reference section 2.1.6.

TABLE 8. SUMMARY OF BLIND GRID RESULTS FOR GEM-3

				By Size			By Depth, m		
Metric	**Overall**	**Standard**	**Non-Standard**	**Small**	**Medium**	**Large**	**< 0.3**	**0.3 to <1**	**>= 1**
RESPONSE STAGE									
P_d	0.80	0.85	0.70	0.90	0.65	0.80	1.00	0.75	0.00
P_d Low 90% Conf	0.71	0.77	0.56	0.79	0.51	0.55	0.95	0.61	0.00
P_{fp}	0.90	-	-	-	-	-	0.87	0.90	1.00
P_{fp} Low 90% Conf	0.84	-	-	-	-	-	0.79	0.82	0.63
P_{ba}	0.40	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	0.45	0.45	0.40	0.45	0.40	0.50	0.60	0.35	0.00
P_d Low 90% Conf	0.36	0.36	0.29	0.32	0.30	0.27	0.48	0.24	0.00
P_{fp}	0.40	-	-	-	-	-	0.40	0.40	0.40
P_{fp} Low 90% Conf	0.34	-	-	-	-	-	0.31	0.30	0.11
P_{ba}	0.00	-	-	-	-	-	-	-	-

6.2 COMPARISON OF ROC CURVES USING ALL ORDNANCE CATEGORIES

Figure 6 shows P_d^{res} versus the respective P_{fp} over all ordnance categories. Figure 7 shows P_d^{disc} versus their respective P_{fp} over all ordnance categories. Figure 7 uses horizontal lines to illustrate the performance of the demonstrator at the recommended discrimination threshold levels, defining the subset of targets the demonstrator would recommend digging based on discrimination.

6.3 COMPARISON OF ROC CURVES USING ORDNANCE LARGER THAN 20 MM

Figure 8 shows the P_d^{res} versus the respective probability of P_{fp} over ordnance larger than 20 mm. Figure 9 shows P_d^{disc} versus the respective P_{fp} over ordnance larger than 20 mm. Figure 9 uses horizontal lines to illustrate the performance of the demonstrator at the recommended discrimination threshold levels, defining the subset of targets the demonstrator would recommend digging based on discrimination.

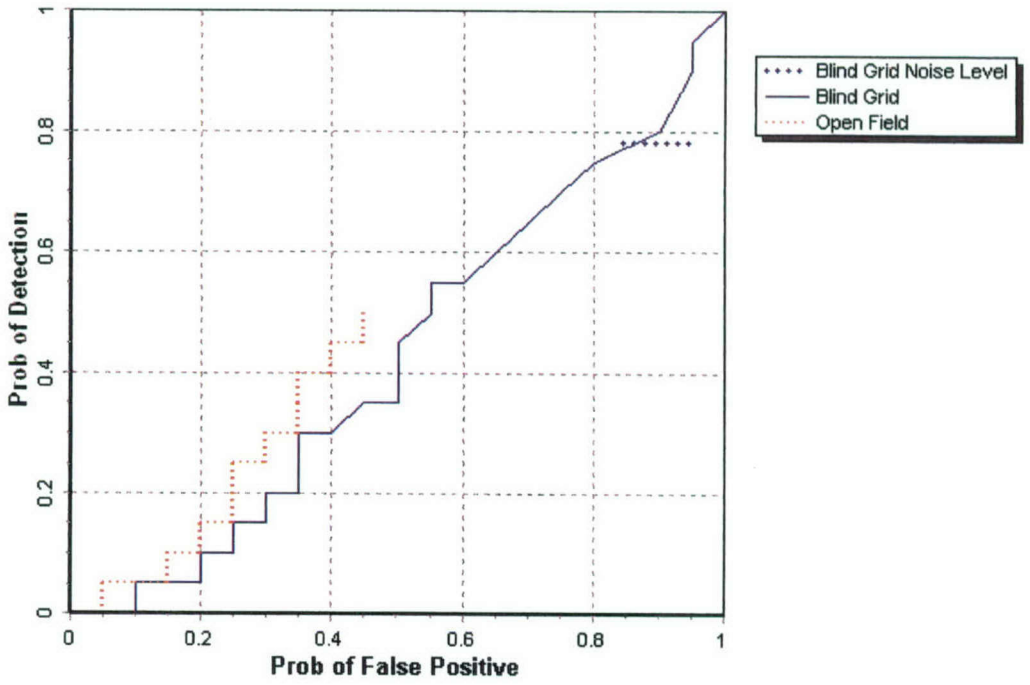

Figure 6. GEM-3 P_d^{res} stages versus the respective P_{fp} over all ordnance categories combined.

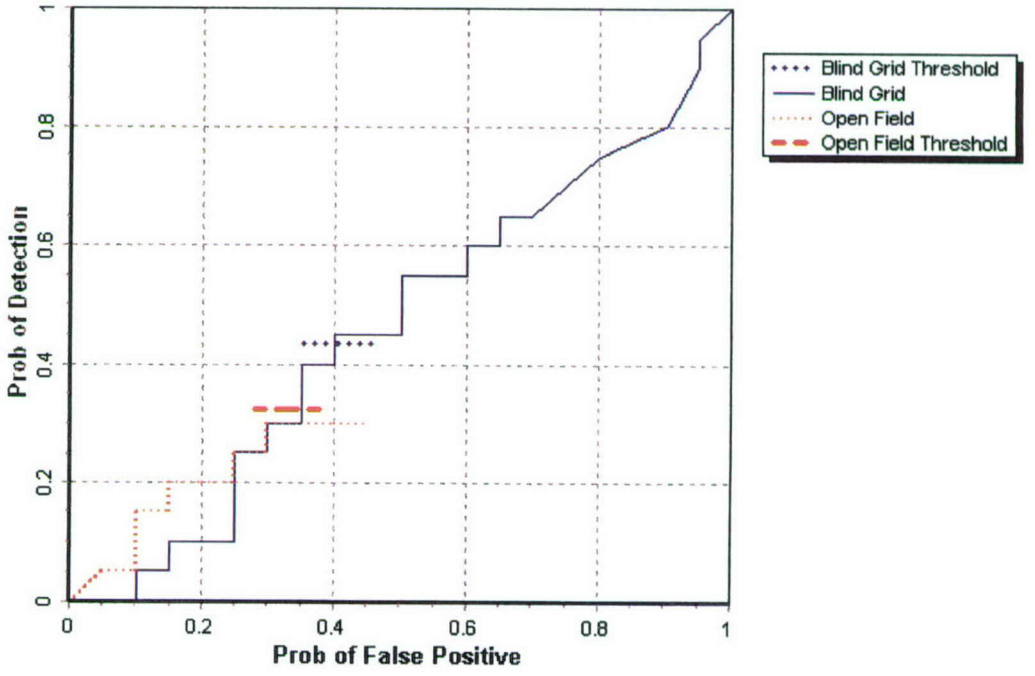

Figure 7. GEM-3 P_d^{disc} versus the respective P_{fp} over all ordnance categories combined.

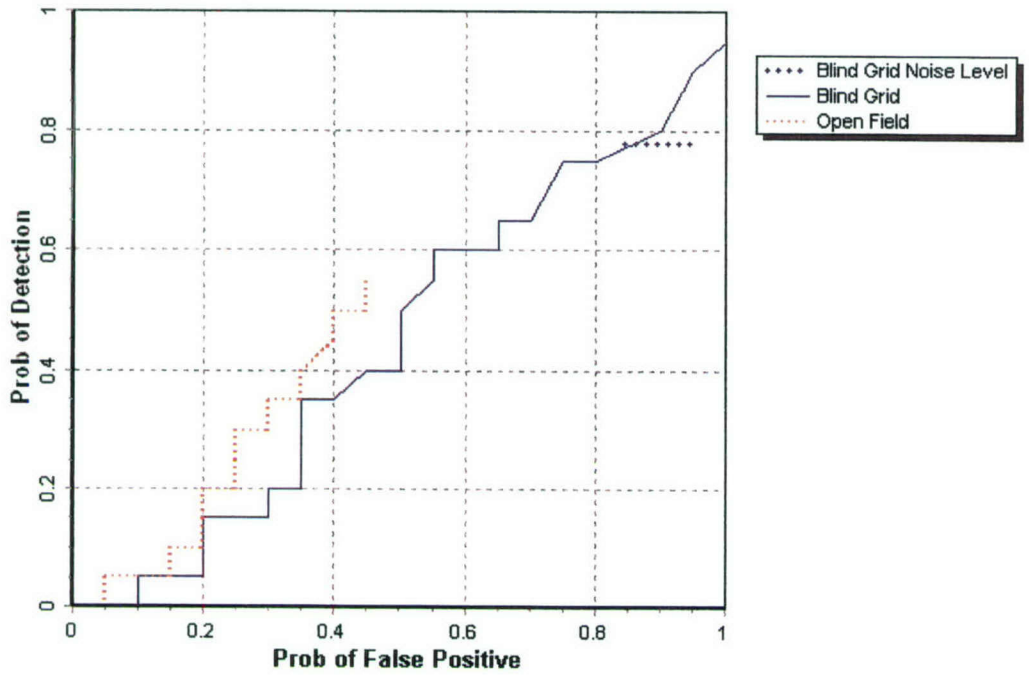

Figure 8. GEM-3 P_d^{res} versus the respective P_{fp} for ordnance larger than 20 mm.

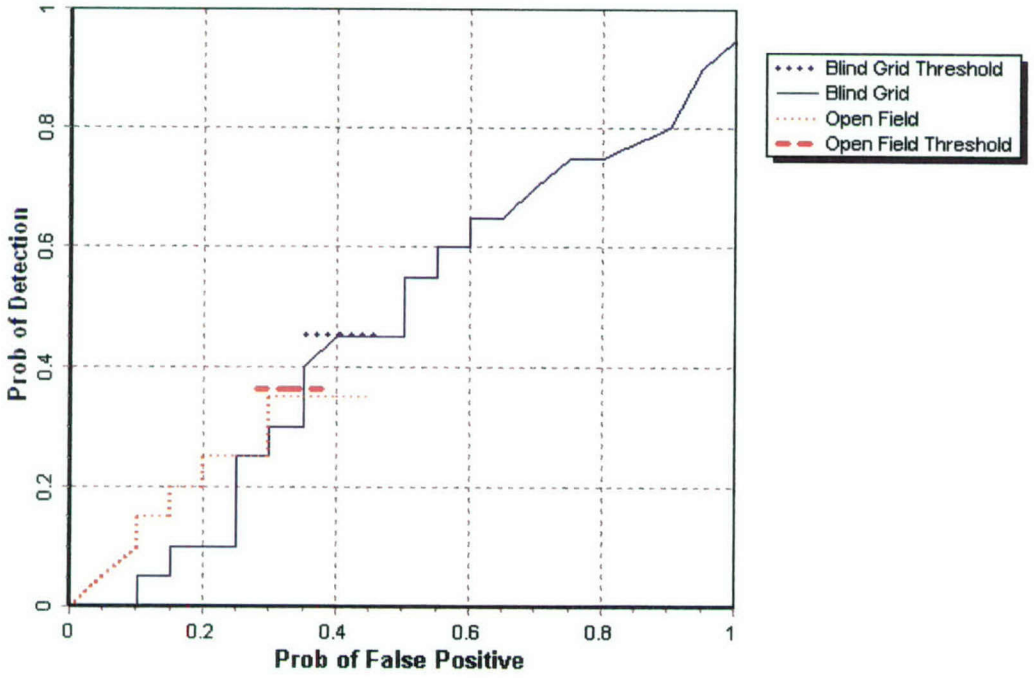

Figure 9. GEM-3 P_d^{disc} versus the respective P_{fp} for ordnance larger than 20 mm.

6.4 STATISTICAL COMPARISONS

Statistical Chi-square significance tests were used to compare results between the Blind Grid and Open Field scenarios. The intent of the comparison is to determine if the feature introduced in each scenario has degrading effect on the performance of the sensor system. However, any modifications in the UXO sensor system during the test, like changes in the processing or changes in the selection of the operating threshold, will also contribute to performance differences.

The Chi-square test for comparison between ratios was used at a significance level of 0.05 to compare Blind Grid to Open Field with regard to P_d^{res}, P_d^{disc}, P_{fp}^{res} and P_{fp}^{disc}, Efficiency and Rejection Rate. These results are presented in Table 11. A detailed explanation and example of the Chi-square application is located in Appendix A.

TABLE 9. CHI-SQUARE RESULTS - BLIND GRID VERSUS OPEN FIELD

Metric	Small	Medium	Large	Overall
P_d^{res}	Significant	Not significant	Not significant	Significant
P_d^{disc}	Significant	Not significant	Not significant	Significant
P_{fp}^{res}	-	-	-	Significant
P_{fp}^{disc}	-	-	-	Not Significant
Efficiency	Not significant	Not significant	Not significant	Significant
Rejection rate	-	-	-	Significant

SECTION 7. APPENDIXES

APPENDIX A. TERMS AND DEFINITIONS

GENERAL DEFINITIONS

Anomaly: Location of a system response deemed to warrant further investigation by the demonstrator for consideration as an emplaced ordnance item.

Detection: An anomaly location that is within R_{halo} of an emplaced ordnance item.

Emplaced Ordnance: An ordnance item buried by the government at a specified location in the test site.

Emplaced Clutter: A clutter item (i.e., non-ordnance item) buried by the government at a specified location in the test site.

R_{halo}: A pre-determined radius about the periphery of an emplaced item (clutter or ordnance) within which a location identified by the demonstrator as being of interest is considered to be a response from that item. For the purpose of this program, a circular halo 0.5 meters in radius will be placed around the center of the object for all clutter and ordnance items less than 0.6 meters in length. When ordnance items are longer than 0.6 meters, the halo becomes an ellipse where the minor axis remains 1 meter and the major axis is equal to the projected length of the ordnance onto the ground plane plus 1 meter.

Small Ordnance: Caliber of ordnance less than or equal to 40 mm (includes 20-mm projectile, 40-mm projectile, submunitions BLU-26, BLU-63, and M42).

Medium Ordnance: Caliber of ordnance greater than 40 mm and less than or equal to 81 mm (includes 57-mm projectile, 60-mm mortar, 2.75-inch Rocket, MK118 Rockeye, 81-mm mortar).

Large Ordnance: Caliber of ordnance greater than 81 mm (includes 105-mm HEAT, 105-mm projectile, 155-mm projectile, 500-lb bomb).

Shallow: Items buried less than 0.3 meter below ground surface.

Medium: Items buried greater than or equal to 0.3 meter and less than 1 meter below ground surface.

Deep: Items buried greater than or equal to 1 meter below ground surface.

Response Stage Noise Level: The level that represents the point below which anomalies are not considered detectable. Demonstrators are required to provide the recommended noise level for the Blind Grid test area.

Discrimination Stage Threshold: The demonstrator selects the threshold level that they believe provides optimum performance of the system by retaining all detectable ordnance and rejecting the maximum amount of clutter. This level defines the subset of anomalies the demonstrator would recommend digging based on discrimination.

Binomially Distributed Random Variable: A random variable of the type which has only two possible outcomes, say success and failure, is repeated for n independent trials with the probability p of success and the probability 1-p of failure being the same for each trial. The number of successes x observed in the n trials is an estimate of p and is considered to be a binomially distributed random variable.

RESPONSE AND DISCRIMINATION STAGE DATA

The scoring of the demonstrator's performance is conducted in two stages. These two stages are termed the RESPONSE STAGE and DISCRIMINATION STAGE. For both stages, the probability of detection (P_d) and the false alarms are reported as receiver-operating characteristic (ROC) curves. False alarms are divided into those anomalies that correspond to emplaced clutter items, measuring the probability of false positive (P_{fp}) and those that do not correspond to any known item, termed background alarms.

The RESPONSE STAGE scoring evaluates the ability of the system to detect emplaced targets without regard to ability to discriminate ordnance from other anomalies. For the RESPONSE STAGE, the demonstrator provides the scoring committee with the location and signal strength of all anomalies that the demonstrator has deemed sufficient to warrant further investigation and/or processing as potential emplaced ordnance items. This list is generated with minimal processing (e.g., this list will include all signals above the system noise threshold). As such, it represents the most inclusive list of anomalies.

The DISCRIMINATION STAGE evaluates the demonstrator's ability to correctly identify ordnance as such, and to reject clutter. For the same locations as in the RESPONSE STAGE anomaly list, the DISCRIMINATION STAGE list contains the output of the algorithms applied in the discrimination-stage processing. This list is prioritized based on the demonstrator's determination that an anomaly location is likely to contain ordnance. Thus, higher output values are indicative of higher confidence that an ordnance item is present at the specified location. For electronic signal processing, priority ranking is based on algorithm output. For other systems, priority ranking is based on human judgment. The demonstrator also selects the threshold that the demonstrator believes will provide "optimum" system performance (i.e., that retains all the detected ordnance and rejects the maximum amount of clutter).

Note: The two lists provided by the demonstrator contain identical numbers of potential target locations. They differ only in the priority ranking of the declarations.

RESPONSE STAGE DEFINITIONS

Response Stage Probability of Detection (P_d^{res}): P_d^{res} = (No. of response-stage detections)/ (No. of emplaced ordnance in the test site).

Response Stage False Positive (fp^{res}): An anomaly location that is within R_{halo} of an emplaced clutter item.

Response Stage Probability of False Positive (P_{fp}^{res}): P_{fp}^{res} = (No. of response-stage false positives)/(No. of emplaced clutter items).

Response Stage Background Alarm: An anomaly in a blind grid cell that contains neither emplaced ordnance nor an emplaced clutter item. An anomaly location in the open field or scenarios that is outside R_{halo} of any emplaced ordnance or emplaced clutter item.

Response Stage Probability of Background Alarm (P_{ba}^{res}): Blind Grid only: P_{ba}^{res} = (No. of response-stage background alarms)/(No. of empty grid locations).

Response Stage Background Alarm Rate (BAR^{res}): Open Field only: BAR^{res} = (No. of response-stage background alarms)/(arbitrary constant).

Note that the quantities P_d^{res}, P_{fp}^{res}, P_{ba}^{res}, and BAR^{res} are functions of t^{res}, the threshold applied to the response-stage signal strength. These quantities can, therefore, be written as $P_d^{res}(t^{res})$, $P_{fp}^{res}(t^{res})$, $P_{ba}^{res}(t^{res})$, and $BAR^{res}(t^{res})$.

DISCRIMINATION STAGE DEFINITIONS

Discrimination: The application of a signal processing algorithm or human judgment to response-stage data that discriminates ordnance from clutter. Discrimination should identify anomalies that the demonstrator has high confidence correspond to ordnance, as well as those that the demonstrator has high confidence correspond to nonordnance or background returns. The former should be ranked with highest priority and the latter with lowest.

Discrimination Stage Probability of Detection (P_d^{disc}): P_d^{disc} = (No. of discrimination-stage detections)/(No. of emplaced ordnance in the test site).

Discrimination Stage False Positive (fp^{disc}): An anomaly location that is within R_{halo} of an emplaced clutter item.

Discrimination Stage Probability of False Positive (P_{fp}^{disc}): P_{fp}^{disc} = (No. of discrimination stage false positives)/(No. of emplaced clutter items).

Discrimination Stage Background Alarm: An anomaly in a blind grid cell that contains neither emplaced ordnance nor an emplaced clutter item. An anomaly location in the open field or scenarios that is outside R_{halo} of any emplaced ordnance or emplaced clutter item.

Discrimination Stage Probability of Background Alarm (P_{ba}^{disc}): P_{ba}^{disc} = (No. of discrimination-stage background alarms)/(No. of empty grid locations).

Discrimination Stage Background Alarm Rate (BAR^{disc}): BAR^{disc} = (No. of discrimination-stage background alarms)/(arbitrary constant).

Note that the quantities P_d^{disc}, P_{fp}^{disc}, P_{ba}^{disc}, and BAR^{disc} are functions of t^{disc}, the threshold applied to the discrimination-stage signal strength. These quantities can, therefore, be written as $P_d^{disc}(t^{disc})$, $P_{fp}^{disc}(t^{disc})$, $P_{ba}^{disc}(t^{disc})$, and $BAR^{disc}(t^{disc})$.

RECEIVER-OPERATING CHARACERISTIC (ROC) CURVES

ROC curves at both the response and discrimination stages can be constructed based on the above definitions. The ROC curves plot the relationship between P_d versus P_{fp} and P_d versus BAR or P_{ba} as the threshold applied to the signal strength is varied from its minimum (t_{min}) to its maximum (t_{max}) value.[1] Figure A-1 shows how P_d versus P_{fp} and P_d versus BAR are combined into ROC curves. Note that the "res" and "disc" superscripts have been suppressed from all the variables for clarity.

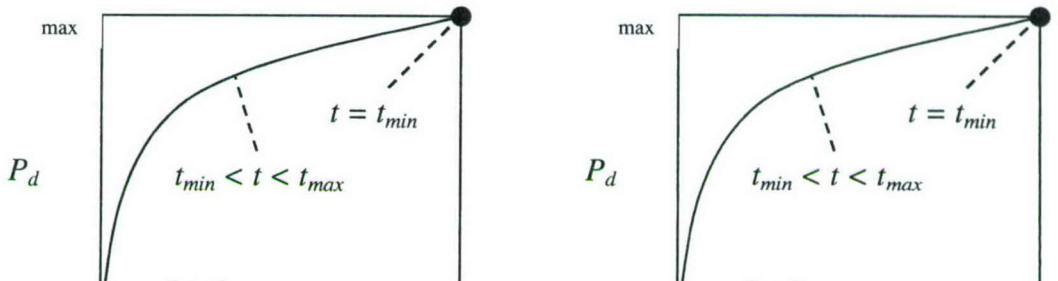

Figure A-1. ROC curves for open-field testing. Each curve applies to both the response and discrimination stages.

[1]Strictly speaking, ROC curves plot the P_d versus P_{ba} over a predetermined and fixed number of detection opportunities (some of the opportunities are located over ordnance and others are located over clutter or blank spots). In an open field scenario, each system suppresses its signal strength reports until some bare-minimum signal response is received by the system. Consequently, the open field ROC curves do not have information from low signal-output locations, and, furthermore, different contractors report their signals over a different set of locations on the ground. These ROC curves are thus not true to the strict definition of ROC curves as defined in textbooks on detection theory. Note, however, that the ROC curves obtained in the Blind Grid test sites are true ROC curves.

METRICS TO CHARACTERIZE THE DISCRIMINATION STAGE

The demonstrator is also scored on efficiency and rejection ratio, which measure the effectiveness of the discrimination stage processing. The goal of discrimination is to retain the greatest number of ordnance detections from the anomaly list, while rejecting the maximum number of anomalies arising from nonordnance items. The efficiency measures the amount of detected ordnance retained by the discrimination, while the rejection ratio measures the fraction of false alarms rejected. Both measures are defined relative to the entire response list, i.e., the maximum ordnance detectable by the sensor and its accompanying false positive rate or background alarm rate.

Efficiency (E): $E = P_d^{disc}(t^{disc})/P_d^{res}(t_{min}^{res})$: measures (at a threshold of interest), the degree to which the maximum theoretical detection performance of the sensor system (as determined by the response stage t_{min}) is preserved after application of discrimination techniques. Efficiency is a number between 0 and 1. An efficiency of 1 implies that all of the ordnance initially detected in the response stage was retained at the specified threshold in the discrimination stage, t^{disc}.

False Positive Rejection Rate (R_{fp}): $R_{fp} = 1 - [P_{fp}^{disc}(t^{disc})/P_{fp}^{res}(t_{min}^{res})]$: measures (at a threshold of interest), the degree to which the sensor system's false positive performance is improved over the maximum false positive performance (as determined by the response stage t_{min}). The rejection rate is a number between 0 and 1. A rejection rate of 1 implies that all emplaced clutter initially detected in the response stage were correctly rejected at the specified threshold in the discrimination stage.

Background Alarm Rejection Rate (R_{ba}):

Blind Grid: $R_{ba} = 1 - [P_{ba}^{disc}(t^{disc})/P_{ba}^{res}(t_{min}^{res})]$
Open Field: $R_{ba} = 1 - [BAR^{disc}(t^{disc})/BAR^{res}(t_{min}^{res})])$

Measures the degree to which the discrimination stage correctly rejects background alarms initially detected in the response stage. The rejection rate is a number between 0 and 1. A rejection rate of 1 implies that all background alarms initially detected in the response stage were rejected at the specified threshold in the discrimination stage.

CHI-SQUARE COMPARISON EXPLANATION:

The Chi-square test for differences in probabilities (or 2 x 2 contingency table) is used to analyze two samples drawn from two different populations to see if both populations have the same or different proportions of elements in a certain category. More specifically, two random samples are drawn, one from each population, to test the null hypothesis that the probability of event A (some specified event) is the same for both populations (ref 4).

A 2 x 2 contingency table is used in the Standardized UXO Technology Demonstration Site Program to determine if there is reason to believe that the proportion of ordnance correctly detected/discriminated by demonstrator X's system is significantly degraded by the more challenging terrain feature introduced. The test statistic of the 2 x 2 contingency table is the Chi-square distribution with one degree of freedom. Since an association between the more challenging terrain feature and relatively degraded performance is sought, a one-sided test is performed. A significance level of 0.05 is chosen which sets a critical decision limit of 2.71 from the Chi-square distribution with one degree of freedom. It is a critical decision limit because if the test statistic calculated from the data exceeds this value, the two proportions tested will be considered significantly different. If the test statistic calculated from the data is less than this value, the two proportions tested will be considered not significantly different.

An exception must be applied when either a 0 or 100 percent success rate occurs in the sample data. The Chi-square test cannot be used in these instances. Instead, Fischer's test is used and the critical decision limit for one-sided tests is the chosen significance level, which in this case is 0.05. With Fischer's test, if the test statistic is less than the critical value, the proportions are considered to be significantly different.

Standardized UXO Technology Demonstration Site examples, where blind grid results are compared to those from the open field and open field results are compared to those from one of the scenarios, follow. It should be noted that a significant result does not prove a cause and effect relationship exists between the two populations of interest; however, it does serve as a tool to indicate that one data set has experienced a degradation in system performance at a large enough level than can be accounted for merely by chance or random variation. Note also that a result that is not significant indicates that there is not enough evidence to declare that anything more than chance or random variation within the same population is at work between the two data sets being compared.

Demonstrator X achieves the following overall results after surveying each of the three progressively more difficult areas using the same system (results indicate the number of ordnance detected divided by the number of ordnance emplaced):

	Blind Grid	Open Field	Moguls
P_d^{res}	100/100 = 1.0	8/10 = .80	20/33 = .61
P_d^{disc}	80/100 = 0.80	6/10 = .60	8/33 = .24

P_d^{res}: BLIND GRID versus OPEN FIELD. Using the example data above to compare probabilities of detection in the response stage, all 100 ordnance out of 100 emplaced ordnance items were detected in the blind grid while 8 ordnance out of 10 emplaced were detected in the open field. Fischer's test must be used since a 100 percent success rate occurs in the data. Fischer's test uses the four input values to calculate a test statistic of 0.0075 that is compared against the critical value of 0.05. Since the test statistic is less than the critical value, the smaller response stage detection rate (0.80) is considered to be significantly less at the 0.05 level of significance. While a significant result does not prove a cause and effect relationship exists between the change in survey area and degradation in performance, it does indicate that the detection ability of demonstrator X's system seems to have been degraded in the open field relative to results from the blind grid using the same system.

P_d^{disc}: BLIND GRID versus OPEN FIELD. Using the example data above to compare probabilities of detection in the discrimination stage, 80 out of 100 emplaced ordnance items were correctly discriminated as ordnance in blind grid testing while 6 ordnance out of 10 emplaced were correctly discriminated as such in open field testing. Those four values are used to calculate a test statistic of 1.12. Since the test statistic is less than the critical value of 2.71, the two discrimination stage detection rates are considered to be not significantly different at the 0.05 level of significance.

P_d^{res}: OPEN FIELD versus MOGULS. Using the example data above to compare probabilities of detection in the response stage, 8 out of 10 and 20 out of 33 are used to calculate a test statistic of 0.56. Since the test statistic is less than the critical value of 2.71, the two response stage detection rates are considered to be not significantly different at the 0.05 level of significance.

P_d^{disc}: OPEN FIELD versus MOGULS. Using the example data above to compare probabilities of detection in the discrimination stage, 6 out of 10 and 8 out of 33 are used to calculate a test statistic of 2.98. Since the test statistic is greater than the critical value of 2.71, the smaller discrimination stage detection rate is considered to be significantly less at the 0.05 level of significance. While a significant result does not prove a cause and effect relationship exists between the change in survey area and degradation in performance, it does indicate that the ability of demonstrator X to correctly discriminate seems to have been degraded by the mogul terrain relative to results from the flat open field using the same system.

(Page A-8 Blank)

APPENDIX B. DAILY WEATHER LOGS

TABLE B-1. WEATHER LOG

Weather Data from Phillips Airfield						
Date	Time, EDST	Average Temperature, °F	Maximum Temperature, °F	Minimum Temperature, °F	RH, %	Precipitation, in.
4/28/2003		8.47	9.04	7.909	89.30	0.00
4/28/2003	1:00	8.09	8.84	7.31	90.40	0.00
4/28/2003	2:00	7.677	8.31	6.643	93.40	0.00
4/28/2003	3:00	6.44	7.443	5.646	96.90	0.00
4/28/2003	4:00	5.945	6.582	5.458	97.60	0.00
4/28/2003	5:00	5.579	6.326	5.126	97.20	0.00
4/28/2003	6:00	5.951	6.792	5.459	96.90	0.00
4/28/2003	7:00	9.49	12.11	6.659	92.00	0.00
4/28/2003	8:00	13.93	15.89	11.98	72.80	0.00
4/28/2003	9:00	18.21	20.13	15.82	50.67	0.00
4/28/2003	10:00	21.49	22.64	19.73	35.86	0.00
4/28/2003	11:00	22.62	23.49	22.03	29.48	0.00
4/28/2003	12:00	23.52	23.88	23.02	26.76	0.00
4/28/2003	13:00	23.96	24.47	23.34	29.50	0.00
4/28/2003	14:00	24.28	24.67	23.87	29.06	0.00
4/28/2003	15:00	24.41	24.79	24.0	30.15	0.00
4/28/2003	16:00	24.50	24.79	24.19	31.95	0.00
4/28/2003	17:00	24.22	24.79	23.73	33.33	0.00
4/28/2003	18:00	23.15	23.86	22.27	37.22	0.00
4/28/2003	19:00	21.59	22.47	20.55	42.97	0.00
4/28/2003	20:00	18.70	20.75	17.37	56.01	0.00
4/28/2003	21:00	16.97	17.44	16.59	67.01	0.00
4/28/2003	22:00	16.39	17.12	15.80	69.33	0.00
4/28/2003	23:00	15.60	15.93	15.13	79.05	0.00
4/29/2003		15.51	16.00	15.00	86.20	0.00
4/29/2003	1:00	15.27	16.00	14.67	89.30	0.00
4/29/2003	2:00	14.85	15.60	13.80	89.30	0.00
4/29/2003	3:00	13.84	14.87	12.94	93.40	0.00
4/29/2003	4:00	12.63	13.47	11.76	98.00	0.00
4/29/2003	5:00	11.22	11.89	10.16	99.70	0.00
4/29/2003	6:00	10.69	11.29	10.22	100.00	0.00
4/29/2003	7:00	12.72	15.29	10.63	100.00	0.00
4/29/2003	8:00	16.15	17.87	14.69	92.80	0.00
4/29/2003	9:00	19.52	21.58	17.73	72.73	0.00
4/29/2003	10:00	22.50	24.36	21.24	60.76	0.00
4/29/2003	11:00	23.95	25.61	21.54	39.87	0.00
4/29/2003	12:00	20.03	21.54	18.49	59.31	0.00
4/29/2003	13:00	18.86	20.17	18.16	73.89	0.00
4/29/2003	15:00	22.26	23.54	21.48	64.28	0.00
4/29/2003	16:00	23.64	24.34	23.14	56.98	0.00
4/29/2003	17:00	23.91	24.53	23.20	55.76	0.00
4/29/2003	18:00	23.76	24.20	23.20	47.62	0.00
4/29/2003	19:00	22.51	23.47	21.22	46.01	0.00
4/29/2003	20:00	19.91	21.48	17.50	55.89	0.00

TABLE B-1 (CONT'D)

Weather Data from Phillips Airfield						
Date	Time, EDST	Average Temperature, °F	Maximum Temperature, °F	Minimum Temperature, °F	RH, %	Precipitation, in.
4/29/2003	21:00	16.77	17.84	15.06	70.18	0.00
4/29/2003	22:00	14.57	15.46	13.34	79.09	0.00
4/29/2003	23:00	13.04	13.60	12.07	89.10	0.00
4/30/2003		12.26	13.15	11.16	93.80	0.00
4/30/2003	1:00	12.36	13.16	11.76	95.20	0.00
4/30/2003	2:00	14.25	15.82	11.89	76.22	0.00
4/30/2003	3:00	15.03	15.89	13.89	61.94	0.00
4/30/2003	4:00	13.90	14.55	12.69	62.60	0.00
4/30/2003	5:00	12.26	12.95	11.29	69.36	0.00
4/30/2003	6:00	12.26	12.76	11.76	67.15	0.00
4/30/2003	7:00	13.83	14.62	12.62	59.27	0.00
4/30/2003	8:00	15.29	16.00	14.48	48.80	0.00
4/30/2003	9:00	16.34	17.06	15.74	44.28	0.00
4/30/2003	10:00	17.35	18.19	16.72	42.14	0.00
4/30/2003	11:00	18.60	19.31	17.98	37.84	0.00
4/30/2003	12:00	19.93	20.83	18.97	35.72	0.00
4/30/2003	13:00	21.84	9999	20.63	34.01	0.00
4/30/2003	14:00	22.10	23.01	21.35	32.38	0.00
4/30/2003	15:00	22.60	23.07	21.87	34.26	0.00
4/30/2003	16:00	22.33	22.87	21.67	35.62	0.00
4/30/2003	17:00	22.54	23.01	21.48	38.99	0.00
4/30/2003	18:00	20.61	21.61	19.75	46.48	0.00
4/30/2003	19:00	18.98	20.02	17.84	47.52	0.00
4/30/2003	20:00	17.56	18.17	16.78	49.83	0.00
4/30/2003	21:00	16.88	21.58	15.99	44.58	0.00
4/30/2003	22:00	16.12	16.66	15.39	46.27	0.00
4/30/2003	23:00	15.07	15.59	14.53	56.36	0.00
5/1/2003		13.39	14.80	12.14	75.02	0.03
5/1/2003	1:00	12.65	12.94	12.34	81.30	0.01
5/1/2003	2:00	12.52	12.94	12.07	87.30	0.01
5/1/2003	3:00	12.67	13.01	12.41	92.50	0.00
5/1/2003	4:00	12.84	13.27	12.41	94.00	0.00
5/1/2003	5:00	13.72	14.14	13.07	91.00	0.00
5/1/2003	6:00	14.08	14.34	13.80	88.10	0.00
5/1/2003	8:00	15.13	15.73	14.80	85.70	0.00
5/1/2003	9:00	17.09	22.05	15.53	84.20	0.00
5/1/2003	10:00	18.03	18.84	17.65	83.70	0.00
5/1/2003	11:00	20.17	23.57	18.84	83.00	0.00
5/1/2003	12:00	20.96	22.10	20.10	80.20	0.00
5/1/2003	13:00	22.03	22.68	21.28	77.51	0.00
5/1/2003	14:00	22.90	23.81	21.74	75.64	0.00
5/1/2003	15:00	24.26	24.80	23.54	71.59	0.00
5/1/2003	16:00	24.91	25.32	24.39	69.12	0.00
5/1/2003	17:00	24.83	25.12	24.59	67.67	0.00
5/1/2003	18:00	24.36	24.99	23.53	68.46	0.00
5/1/2003	19:00	23.34	23.93	22.27	69.90	0.00

TABLE B-1 (CONT'D)

Weather Data from Phillips Airfield						
Date	Time, EDST	Average Temperature, °F	Maximum Temperature, °F	Minimum Temperature, °F	RH, %	Precipitation, in.
5/1/2003	20:00	21.58	22.47	20.82	75.06	0.00
5/1/2003	21:00	20.09	21.02	19.17	81.20	0.00
5/1/2003	22:00	19.57	20.37	18.97	84.40	0.00
5/1/2003	23:00	19.42	20.24	18.84	83.70	0.00
5/2/2003		18.37	22.57	16.85	88.50	0.00
5/2/2003	1:00	16.55	17.72	15.66	95.00	0.00
5/2/2003	2:00	15.98	16.33	15.53	98.40	0.00
5/2/2003	3:00	15.73	16.13	14.67	98.60	0.00
5/2/2003	4:00	15.94	16.60	14.60	98.80	0.00
5/2/2003	5:00	15.48	16.80	14.40	98.20	0.00
5/2/2003	6:00	15.35	15.93	14.94	99.60	0.00
5/2/2003	7:00	17.19	21.26	15.27	98.10	0.00
5/2/2003	8:00	19.39	22.26	18.40	89.40	0.00
5/2/2003	9:00	20.58	20.97	19.99	81.60	0.00
5/2/2003	10:00	20.99	21.96	20.23	80.10	0.00
5/2/2003	11:00	22.50	27.01	21.29	76.99	0.00
5/2/2003	12:00	23.05	27.93	21.68	74.35	0.00
5/2/2003	13:00	23.51	27.60	23.00	71.63	0.00
5/2/2003	14:00	24.95	25.98	24.07	66.58	0.00
5/2/2003	15:00	25.15	28.11	24.25	69.76	0.00
5/2/2003	16:00	26.25	29.90	25.11	65.95	0.00
5/2/2003	17:00	26.16	30.30	25.51	62.73	0.00
5/2/2003	18:00	25.58	28.57	24.52	66.34	0.00
5/2/2003	19:00	23.80	27.91	22.07	75.44	0.00
5/2/2003	20:00	22.64	23.54	21.67	68.22	0.00
5/2/2003	21:00	21.51	22.61	20.09	56.21	0.00
5/2/2003	22:00	18.61	20.16	16.71	59.61	0.00
5/2/2003	23:00	15.85	16.77	15.25	67.33	0.00
5/3/2003		14.97	15.39	14.53	69.79	0.00
5/3/2003	1:00	14.53	14.87	14.20	70.83	0.00
5/3/2003	3:00	13.38	14.00	12.81	74.98	0.00
5/3/2003	4:00	12.55	12.94	12.22	77.29	0.00
5/3/2003	5:00	12.42	12.69	12.09	76.86	0.00
5/3/2003	6:00	12.13	12.42	11.96	77.31	0.00
5/3/2003	7:00	12.67	13.09	12.29	75.69	0.00
5/3/2003	8:00	13.41	13.87	12.89	72.56	0.00
5/3/2003	9:00	13.91	14.34	13.60	70.59	0.00
5/3/2003	10:00	14.71	18.73	14.07	66.70	0.00
5/3/2003	11:00	15.56	19.99	15.13	63.93	0.00
5/3/2003	12:00	17.14	19.65	15.99	62.18	0.00
5/3/2003	13:00	16.59	17.78	16.12	62.10	0.00
5/3/2003	14:00	18.41	21.63	16.52	58.39	0.00
5/3/2003	15:00	19.10	21.36	18.24	55.14	0.00
5/3/2003	16:00	19.25	22.03	17.84	57.66	0.00
5/3/2003	17:00	18.72	21.10	16.51	57.25	0.00
5/3/2003	18:00	16.57	17.10	15.98	63.61	0.00
5/3/2003	19:00	15.54	16.18	14.79	70.77	0.00

TABLE B-1 (CONT'D)

Weather Data from Phillips Airfield						
Date	Time, EDST	Average Temperature, °F	Maximum Temperature, °F	Minimum Temperature, °F	RH, %	Precipitation, in.
5/3/2003	20:00	14.52	16.80	13.60	78.86	0.00
5/3/2003	21:00	13.33	16.73	11.87	84.60	0.00
5/3/2003	22:00	11.74	12.09	11.36	86.10	0.00
5/3/2003	23:00	11.36	11.82	10.76	85.80	0.00
5/4/2003		10.70	11.16	10.03	84.30	0.00
5/4/2003	1:00	9.89	10.30	9.50	86.80	0.00
5/4/2003	2:00	9.73	10.23	9.23	90.10	0.00
5/4/2003	3:00	9.10	9.77	8.57	93.80	0.00
5/4/2003	4:00	9.42	9.90	8.64	90.40	0.00
5/4/2003	5:00	9.43	10.04	8.84	90.80	0.00
5/4/2003	6:00	9.13	10.10	8.64	94.20	0.00
5/4/2003	7:00	10.43	10.77	9.97	87.30	0.00
5/4/2003	8:00	10.70	11.23	9.90	88.60	0.00
5/4/2003	9:00	12.22	13.09	11.09	82.90	0.00
5/4/2003	10:00	14.46	18.95	12.96	68.32	0.00
5/4/2003	11:00	13.82	14.07	13.41	63.27	0.00
5/4/2003	12:00	14.81	18.93	13.87	61.87	0.00
5/4/2003	13:00	17.14	19.06	15.93	59.61	0.00
5/4/2003	14:00	17.72	19.99	16.72	56.07	0.00
5/4/2003	15:00	18.11	19.97	16.72	49.45	0.00
5/4/2003	16:00	19.18	20.83	18.04	39.90	0.00
5/4/2003	17:00	18.53	21.16	17.44	37.73	0.00
5/4/2003	18:00	18.60	20.70	17.77	41.14	0.00
5/4/2003	19:00	17.54	20.17	14.92	42.13	0.00
5/4/2003	21:00	11.82	16.27	9.69	66.93	0.00
5/4/2003	22:00	10.76	11.82	9.37	61.78	0.00
5/4/2003	23:00	9.31	10.03	8.24	67.05	0.00
5/5/2003		6.604	8.51	5.644	83.10	0.00
5/5/2003	1:00	6.069	6.845	5.458	85.90	0.00
5/5/2003	2:00	4.864	5.792	3.659	92.10	0.00
5/5/2003	3:00	4.019	4.393	3.593	96.10	0.00
5/5/2003	4:00	4.454	4.726	3.993	97.30	0.00
5/5/2003	5:00	4.637	5.192	4.193	96.30	0.00
5/5/2003	6:00	5.453	5.926	4.992	93.90	0.00
5/5/2003	7:00	7.591	9.52	5.792	92.10	0.00
5/5/2003	8:00	10.30	10.71	9.52	82.90	0.00
5/5/2003	9:00	10.53	10.90	10.24	79.71	0.00
5/5/2003	10:00	11.66	12.69	10.77	75.79	0.00
5/5/2003	11:00	12.36	12.82	11.95	54.84	0.00
5/5/2003	12:00	12.61	13.21	11.95	50.15	0.00
5/5/2003	13:00	12.54	13.07	12.01	57.31	0.00
5/5/2003	14:00	11.97	12.34	11.67	72.03	0.01
5/5/2003	15:00	11.81	12.41	11.22	75.57	0.00
5/5/2003	16:00	10.47	11.35	9.69	75.27	0.01
5/5/2003	17:00	9.47	9.89	9.03	76.85	0.00
5/5/2003	18:00	9.10	9.50	8.56	70.36	0.01
5/5/2003	19:00	8.43	8.83	8.17	75.79	0.00

TABLE B-1 (CONT'D)

Weather Data from Phillips Airfield						
Date	Time, EDST	Average Temperature, °F	Maximum Temperature, °F	Minimum Temperature, °F	RH, %	Precipitation, in.
5/5/2003	20:00	8.84	9.03	8.50	82.00	0.00
5/5/2003	21:00	9.41	9.70	8.90	81.40	0.00
5/5/2003	22:00	9.75	9.97	9.50	82.50	0.00
5/5/2003	23:00	9.87	10.16	9.63	83.60	0.00
5/6/2003		10.20	10.42	9.96	85.10	0.00
5/6/2003	1:00	10.27	10.49	10.02	92.90	0.00
5/6/2003	2:00	10.43	10.56	10.22	95.30	0.00
5/6/2003	3:00	10.48	10.62	10.29	98.40	0.00
5/6/2003	4:00	10.51	10.69	10.29	99.00	0.01
5/6/2003	5:00	10.53	10.69	10.36	99.20	0.00
5/6/2003	6:00	10.58	10.82	10.29	99.30	0.01
5/6/2003	7:00	10.87	11.09	10.56	99.00	0.00
5/6/2003	8:00	11.06	11.42	10.69	98.40	0.00
5/6/2003	9:00	11.36	11.69	11.09	98.30	0.00
5/6/2003	10:00	11.71	12.27	11.35	97.60	0.00
5/6/2003	11:00	12.56	13.20	12.01	95.00	0.00
5/6/2003	12:00	13.59	14.20	12.87	91.90	0.00
5/6/2003	13:00	14.36	14.93	13.87	89.00	0.00
5/6/2003	15:00	16.41	17.12	15.53	80.10	0.00
5/6/2003	16:00	16.01	16.72	15.71	82.10	0.00
5/6/2003	17:00	15.96	16.25	15.65	81.90	0.00
5/6/2003	18:00	16.23	16.59	15.92	80.90	0.00
5/6/2003	19:00	15.71	16.19	14.99	84.30	0.00
5/6/2003	20:00	14.03	15.13	13.07	91.80	0.00
5/6/2003	21:00	12.76	13.40	11.87	96.80	0.00
5/6/2003	22:00	11.80	12.42	11.15	99.10	0.00
5/6/2003	23:00	11.45	12.55	10.76	99.00	0.00
5/7/2003		10.95	11.62	9.96	99.60	0.00
5/7/2003	1:00	10.65	11.22	10.29	99.70	0.00
5/7/2003	2:00	10.27	10.82	9.49	99.90	0.00
5/7/2003	3:00	10.26	10.96	9.36	100.00	0.00
5/7/2003	4:00	10.13	10.82	9.69	100.00	0.00
5/7/2003	5:00	9.81	10.57	8.63	100.00	0.00
5/7/2003	6:00	9.37	10.37	8.70	100.00	0.00
5/7/2003	7:00	11.68	13.22	10.23	100.00	0.00
5/7/2003	8:00	13.71	14.34	13.09	100.00	0.00
5/7/2003	9:00	14.86	15.93	14.14	99.80	0.00
5/7/2003	10:00	17.18	19.19	15.73	90.40	0.00
5/7/2003	11:00	20.13	20.97	19.05	81.20	0.00
5/7/2003	12:00	20.36	21.02	19.90	81.60	0.00
5/7/2003	13:00	22.83	23.94	20.88	72.75	0.00
5/7/2003	14:00	24.13	24.72	23.67	68.01	0.00
5/7/2003	15:00	25.00	25.78	24.32	66.81	0.00
5/7/2003	16:00	25.84	26.31	25.18	64.78	0.00
5/7/2003	17:00	24.73	25.91	23.72	70.01	0.00
5/7/2003	18:00	23.24	23.85	22.74	74.64	0.00

TABLE B-1 (CONT'D)

Weather Data from Phillips Airfield						
Date	Time, EDST	Average Temperature, °F	Maximum Temperature, °F	Minimum Temperature, °F	RH, %	Precipitation, in.
5/7/2003	19:00	21.89	22.94	20.88	84.30	0.00
5/7/2003	20:00	20.72	21.10	20.17	91.80	0.19
5/7/2003	21:00	19.95	20.30	19.57	97.90	0.01
5/7/2003	22:00	19.61	19.83	19.43	99.20	0.00
5/7/2003	23:00	19.41	19.63	19.17	99.40	0.36

APPENDIX C. SOIL MOISTURE

Daily Soil Moisture Logs

Demonstrator: GEOPHEX
Date: APRIL 28, 2003
Times: 925 (AM), 1625 hrs (PM)

Probe Location	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	77.8	78.2
	6 to 12	65.9	66.8
	12 to 24	73.1	77.1
	24 to 36	61.9	62.1
	36 to 48	52.3	51.2
Wooded Area	0 to 6	No Readings Taken	No Readings Taken
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open Area	0 to 6	15.8	16.2
	6 to 12	1.2	1.3
	12 to 24	22.7	22.9
	24 to 36	30.2	29.9
	36 to 48	42.8	43.1

Demonstrator: GEOPHEX
Date: APRIL 29, 2003
Times: 920 hrs (AM), 1605 hrs (PM)

Probe Location	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	78.4	77.2
	6 to 12	64.2	65.8
	12 to 24	73.8	74.1
	24 to 36	62.9	60.3
	36 to 48	51.1	50.9
Wooded Area	0 to 6	84.3	84.9
	6 to 12	64.8	64.9
	12 to 24	62.9	63.4
	24 to 36	88.3	87.9
	36 to 48	48.3	48.7
Open Area	0 to 6	13.1	16.2
	6 to 12	0.6	1.4
	12 to 24	21.9	22.9
	24 to 36	29.0	29.5
	36 to 48	41.9	42.7

Demonstrator: GEOPHEX
Date: APRIL 30, 2003
Times: 908 hrs (AM), 1513 hrs (PM)

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	77.7	77.2
	6 to 12	66.2	65.7
	12 to 24	73.9	74.3
	24 to 36	61.2	60.8
	36 to 48	51.3	51.8
Wooded Area	0 to 6	82.1	82.1
	6 to 12	65.1	65.4
	12 to 24	63.1	63.7
	24 to 36	87.6	87.9
	36 to 48	49.1	49.0
Open Area	0 to 6	3.1	3.0
	6 to 12	0.2	0.3
	12 to 24	19.9	19.2
	24 to 36	27.9	28.7
	36 to 48	40.7	40.3

Demonstrator: GEOPHEX
Date: MAY 1, 2003
Times: 905 hrs (AM), 1452 (PM)

Probe Location	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	77.9	77.3
	6 to 12	66.8	65.9
	12 to 24	73.5	74.2
	24 to 36	60.8	59.8
	36 to 48	52.1	51.4
Wooded Area	0 to 6	82.0	81.2
	6 to 12	66.1	67.3
	12 to 24	63.3	62.9
	24 to 36	86.8	85.9
	36 to 48	49.8	49.3
Open Area	0 to 6	6.2	8.4
	6 to 12	1.2	0.9
	12 to 24	18.7	19.3
	24 to 36	28.5	28.1
	36 to 48	39.8	40.3

Demonstrator: GEOPHEX
Date: MAY 2, 2003
Times: 815 hrs (AM), 1410 hrs (PM)

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	78.3	77.8
	6 to 12	66.2	66.2
	12 to 24	75.3	75.1
	24 to 36	64.1	63.8
	36 to 48	50.1	49.8
Wooded Area	0 to 6	76.9	76.3
	6 to 12	64.2	63.8
	12 to 24	86.9	86.9
	24 to 36	63.5	63.1
	36 to 48	50.9	50.2
Open Area	0 to 6	11.9	11.4
	6 to 12	0.7	0.3
	12 to 24	20.8	20.2
	24 to 36	26.9	26.3

Demonstrator: GEOPHEX
Date: MAY 3, 2003
Times: 850 hrs (AM), 1515 (PM)

Probe Location	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	78.7	78.3
	6 to 12	67.0	66.4
	12 to 24	74.2	74.8
	24 to 36	62.9	62.5
	36 to 48	50.4	50.6
Wooded Area	0 to 6	77.6	77.6
	6 to 12	63.3	63.1
	12 to 24	85.8	86.5
	24 to 36	62.7	61.9
	36 to 48	49.9	48.2
Open Area	0 to 6	11.7	11.6
	6 to 12	0.3	0.5
	12 to 24	20.0	20.4
	24 to 36	27.3	26.9
	36 to 48	40.0	40.3

Demonstrator: GEOPHEX
Date: MAY 5, 2003
Times: 840 hrs (AM), 1510 hrs (PM)

Probe Location	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	77.3	80.4
	6 to 12	65.6	66.2
	12 to 24	74.5	72.2
	24 to 36	61.5	59.7
	36 to 48	49.9	31.7
Wooded Area	0 to 6	No Readings Taken	53.4
	6 to 12		65.8
	12 to 24		91.4
	24 to 36		64.2
	36 to 48		51.5
Open Area	0 to 6	11.1	No Readings Taken
	6 to 12	0.5	
	12 to 24	18.7	
	24 to 36	26.2	
	36 to 48	38.8	

Demonstrator: GEOPHEX
Date: MAY 6, 2003
Times: 830 hrs (AM), 1422 (PM)

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	60.7	83.0
	6 to 12	72.5	74.2
	12 to 24	75.7	75.3
	24 to 36	62.1	61.7
	36 to 48	49.6	49.5
Wooded Area	0 to 6	73.0	73.0
	6 to 12	71.3	72.8
	12 to 24	93.4	92.4
	24 to 36	60.5	62.4
	36 to 48	51.7	52.4
Open Area	0 to 6	12.2	9.7
	6 to 12	1.0	0.5
	12 to 24	18.4	18.0
	24 to 36	25.4	25.0
	36 to 48	37.9	37.7

Demonstrator: GEOPHEX
Date: MAY 7, 2003
Times: 905 hrs (AM), 1337 hrs (PM)

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	84.1	77.6
	6 to 12	73.0	76.8
	12 to 24	75.5	76.3
	24 to 36	62.0	62.3
	36 to 48	49.1	49.3
Wooded Area	0 to 6	No Readings Taken	73.3
	6 to 12		73.6
	12 to 24		93.7
	24 to 36		60.1
	36 to 48		50.1
Open Area	0 to 6	10.2	10.0
	6 to 12	0.2	0.2
	12 to 24	18.1	17.8
	24 to 36	25.0	24.6
	36 to 48	37.4	37.1

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Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status - Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
4/28/2003	2	CALIBRATION LANES	845	1220	215	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION	GPS	NA	LINEAR	SUNNY	MUDDY
4/28/2003	1	CALIBRATION LANES	1220	1408	108	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
4/28/2003	1	CALIBRATION LANES	1408	1428	20	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHANGE BATTERY	GPS	NA	LINEAR	SUNNY	MUDDY
4/28/2003	1	CALIBRATION LANES	1428	1520	48	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOADING DATA	GPS	NA	LINEAR	SUNNY	MUDDY
4/28/2003	1	BLIND TEST GRID	1520	1631	71	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
4/28/2003	1	BLIND TEST GRID	1631	1650	19	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHANGE BATTERY	GPS	NA	LINEAR	SUNNY	MUDDY
4/28/2003	1	BLIND TEST GRID	1650	1905	135	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
4/28/2003	1	BLIND TEST GRID	1905	1915	10	SET-UP/DAILY START/STOP/CALIBRATION	END OF DAILY OPERATIONS/EQUIPMENT BREAKDOWN	GPS	NA	LINEAR	SUNNY	MUDDY
4/29/2003	1	BLIND TEST GRID	800	900	60	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION	GPS	NA	LINEAR	CLOUDY	MUDDY
4/29/2003	1	BLIND TEST GRID	900	1045	105	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
4/29/2003	1	BLIND TEST GRID	1045	1103	18	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHANGE BATTERY	GPS	NA	LINEAR	CLOUDY	MUDDY
4/29/2003	1	BLIND TEST GRID	1103	1357	174	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
4/29/2003	1	OPEN FIELD	1357	1415	18	SET-UP/DAILY START/STOP/CALIBRATION	SET UP CONES	GPS	NA	LINEAR	CLOUDY	MUDDY
4/29/2003	1	OPEN FIELD	1415	1610	115	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
4/29/2003	1	OPEN FIELD	1610	1650	40	BREAK/LUNCH	BREAK/LUNCH	GPS	NA	LINEAR	CLOUDY	MUDDY
4/29/2003	1	OPEN FIELD	1650	1855	125	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
4/29/2003	1	OPEN FIELD	1855	1915	20	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOADING DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
4/29/2003	1	OPEN FIELD	1915	1930	15	SET-UP/DAILY START/STOP/CALIBRATION	END OF DAILY OPERATIONS/EQUIPMENT BREAKDOWN	GPS	NA	LINEAR	CLOUDY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status - Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
4/30/2003	1	OPEN FIELD	800	845	45	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION	GPS	NA	LINEAR	CLOUDY	MUDDY
4/30/2003	1	OPEN FIELD	845	1150	189	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
4/30/2003	1	OPEN FIELD	1150	1225	31	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHECK DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
4/30/2003	1	OPEN FIELD	1225	1305	40	BREAK/LUNCH	BREAK/LUNCH	GPS	NA	LINEAR	CLOUDY	MUDDY
5/1/2003	1	OPEN FIELD	803	1041	158	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	1	OPEN FIELD	1041	1130	49	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	1	OPEN FIELD	1130	1152	22	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHANGE BATTERY	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	1	OPEN FIELD	1152	1239	47	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	1	OPEN FIELD	1239	1323	44	SET-UP/DAILY START/STOP/CALIBRATION	SET UP CONES	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	1	OPEN FIELD	1323	1438	75	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	1	OPEN FIELD	1438	1449	11	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOADING DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	1	OPEN FIELD	1449	1530	41	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/2/2003	1	OPEN FIELD	755	954	119	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	1	OPEN FIELD	954	1035	41	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	1	OPEN FIELD	1035	1116	41	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOADING DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	1	OPEN FIELD	1116	1320	124	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	1	OPEN FIELD	1320	1405	45	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOADING DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	1	OPEN FIELD	1405	1455	50	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	1	OPEN FIELD	1455	1535	40	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOADING DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	1	OPEN FIELD	1535	1625	50	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHECK DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/6/2003	1	OPEN FIELD	1240	1245	5	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	1	OPEN FIELD	1245	1303	18	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status - Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
5/6/2003	1	OPEN FIELD	1303	1351	48	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHANGE BATTERY	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	1	OPEN FIELD	1351	1607	136	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	1	OPEN FIELD	1607	1640	33	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOADING DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	1	OPEN FIELD	1640	1710	30	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	1	OPEN FIELD	900	931	31	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	1	OPEN FIELD	931	1041	70	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	2	OPEN FIELD	1041	1044	3	EQUIPMENT FAILURE	GPS SYSTEM NOT WORKING	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	2	OPEN FIELD	1044	1054	10	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	2	OPEN FIELD	1054	1143	49	EQUIPMENT FAILURE	GPS SYSTEM NOT WORKING	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	2	OPEN FIELD	1143	1205	23	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	2	OPEN FIELD	1205	1245	40	EQUIPMENT FAILURE	GPS SYSTEM NOT WORKING	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	2	OPEN FIELD	1245	1338	53	BREAK/LUNCH	BREAK/LUNCH	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	2	OPEN FIELD	1338	1400	22	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	2	OPEN FIELD	1400	1408	8	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOADING DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	2	OPEN FIELD	1408	1515	67	DEMOBILIZATION	DEMOBILIZATION	GPS	NA	LINEAR	SUNNY	MUDDY
4/28/2003	2	OPEN FIELD	845	1220	215	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION	GPS	NA	LINEAR	SUNNY	MUDDY
4/28/2003	2	OPEN FIELD	1220	1810	350	EQUIPMENT FAILURE	SOFTWARE ISSUE, NEVER GOT STARTED	GPS	NA	LINEAR	SUNNY	MUDDY
4/28/2003	2	OPEN FIELD	1810	1915	65	SET-UP/DAILY START/STOP/CALIBRATION	END OF DAILY OPERATIONS/EQUIPMENT BREAKDOWN	GPS	NA	LINEAR	SUNNY	MUDDY
4/29/2003	3	OPEN FIELD	800	1510	430	EQUIPMENT FAILURE	SOFTWARE ISSUE, NEVER GOT STARTED	GPS	NA	LINEAR	CLOUDY	MUDDY
4/29/2003	1	OPEN FIELD	1510	1840	210	EQUIPMENT FAILURE	SOFTWARE ISSUE, NEVER GOT STARTED	GPS	NA	LINEAR	CLOUDY	MUDDY
4/29/2003	1	OPEN FIELD	1840	1930	50	SET-UP/DAILY START/STOP/CALIBRATION	END OF DAILY OPERATIONS/EQUIPMENT BREAKDOWN	GPS	NA	LINEAR	CLOUDY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status - Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
4/30/2003	3	OPEN FIELD	800	1015	135	EQUIPMENT FAILURE	SOFTWARE ISSUE, NEVER GOT STARTED	GPS	NA	LINEAR	CLOUDY	MUDDY
4/30/2003	1	OPEN FIELD	1015	1305	170	EQUIPMENT FAILURE	SOFTWARE ISSUE, NEVER GOT STARTED	GPS	NA	LINEAR	CLOUDY	MUDDY
4/30/2003	3	OPEN FIELD	1305	1900	355	EQUIPMENT FAILURE	SOFTWARE ISSUE, NEVER GOT STARTED	GPS	NA	LINEAR	CLOUDY	MUDDY
4/30/2003	3	OPEN FIELD	1900	1915	15	SET-UP/DAILY START/STOP/CALIBRATION	END OF DAILY OPERATIONS/EQUIPMENT BREAKDOWN	GPS	NA	LINEAR	CLOUDY	MUDDY
5/1/2003	3	OPEN FIELD	803	1030	147	SET-UP/DAILY START/STOP/CALIBRATION	DAILY SET UP	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1030	1035	5	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	MINE GRID	1035	1036	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1036	1038	2	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	MINE GRID	1038	1039	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1039	1041	2	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	MINE GRID	1041	1042	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1042	1044	2	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	MINE GRID	1044	1045	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1045	1047	2	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	MINE GRID	1047	1048	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1048	1054	6	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	MINE GRID	1054	1055	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1055	1058	3	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	MINE GRID	1058	1059	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1059	1100	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	MINE GRID	1100	1101	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1101	1103	2	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	MINE GRID	1103	1104	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1104	1208	64	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1208	1228	20	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHANGE BATTERY	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1228	1255	27	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOAD DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1255	1414	79	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	3	OPEN FIELD	1414	1444	30	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOAD DATA	GPS	NA	LINEAR	SUNNY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status - Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
5/1/2003	3	OPEN FIELD	1444	1530	46	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHECK DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1530	1621	51	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHECK DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1621	1635	14	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1635	1651	16	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHECK DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1651	1717	26	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	BLIND TEST GRID	1717	1718	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1718	1720	2	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	BLIND TEST GRID	1720	1721	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1721	1723	2	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	BLIND TEST GRID	1723	1724	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1724	1726	2	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	BLIND TEST GRID	1726	1727	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1727	1730	3	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	BLIND TEST GRID	1730	1731	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1731	1732	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	BLIND TEST GRID	1732	1733	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1733	1736	3	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	BLIND TEST GRID	1736	1737	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1737	1739	2	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	BLIND TEST GRID	1739	1740	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1740	1743	3	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	BLIND TEST GRID	1743	1744	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1744	1745	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status - Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
5/1/2003	4	BLIND TEST GRID	1745	1746	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1746	1749	3	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	BLIND TEST GRID	1749	1750	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1750	1751	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	BLIND TEST GRID	1751	1752	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1752	1755	3	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	BLIND TEST GRID	1755	1756	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1756	1757	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1757	1813	16	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHECK DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1813	1910	57	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/1/2003	4	OPEN FIELD	1910	1930	20	SET-UP/DAILY START/STOP/CALIBRATION	END OF DAILY OPERATIONS/EQUIPMENT BREAKDOWN	GPS	NA	LINEAR	SUNNY	MUDDY
5/2/2003	5	OPEN FIELD	755	1112	197	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	OPEN FIELD	1112	1113	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	BLIND TEST GRID	1113	1114	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	OPEN FIELD	1114	1120	6	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	BLIND TEST GRID	1120	1121	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	OPEN FIELD	1121	1131	10	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	BLIND TEST GRID	1131	1132	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	OPEN FIELD	1132	1140	8	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	OPEN FIELD	1140	1557	257	EQUIPMENT FAILURE	REPLACE GPS CONSOLE, BROKEN PIN	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	OPEN FIELD	1557	1558	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	BLIND TEST GRID	1558	1559	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	OPEN FIELD	1559	1605	6	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status - Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
5/2/2003	5	BLIND TEST GRID	1605	1606	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	OPEN FIELD	1606	1613	7	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	BLIND TEST GRID	1613	1614	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	OPEN FIELD	1614	1620	6	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	5	BLIND TEST GRID	1620	1621	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	OPEN FIELD	1621	1628	7	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	BLIND TEST GRID	1628	1629	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	OPEN FIELD	1629	1636	7	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	BLIND TEST GRID	1636	1637	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	OPEN FIELD	1637	1644	7	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	BLIND TEST GRID	1644	1645	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	OPEN FIELD	1645	1652	7	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	BLIND TEST GRID	1652	1653	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	OPEN FIELD	1653	1658	5	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	BLIND TEST GRID	1658	1659	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	OPEN FIELD	1659	1706	7	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	BLIND TEST GRID	1706	1707	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	OPEN FIELD	1707	1745	38	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
5/2/2003	6	OPEN FIELD	1745	1815	30	SET-UP/DAILY START/STOP/CALIBRATION	END OF DAILY OPERATIONS/EQUIPMENT BREAKDOWN	GPS	NA	LINEAR	CLOUDY	MUDDY
5/3/2003	2	OPEN FIELD	748	1108	200	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1108	1116	8	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1116	1117	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1117	1124	7	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1124	1125	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status - Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
5/3/2003	2	OPEN FIELD	1125	1133	8	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	BLIND TEST GRID	1133	1134	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1134	1144	70	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1144	1145	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1145	1152	7	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1152	1153	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1153	1200	7	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1200	1201	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1201	1207	6	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1207	1216	9	DOWNTIME DUE TO EQUIP MAIN/CHECK	CHECK DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1216	1217	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1217	1218	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1218	1224	6	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1224	1225	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1225	1231	6	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1231	1232	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1232	1238	6	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1238	1239	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1239	1244	5	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1244	1245	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1245	1252	7	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1252	1253	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1253	1259	6	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1259	1300	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1300	1305	5	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1305	1306	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1306	1312	6	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1312	1313	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1313	1319	6	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1319	1320	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1320	1326	6	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1326	1341	15	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOAD DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1341	1342	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status - Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
5/3/2003	2	OPEN FIELD	1342	1347	5	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	MINE GRID	1347	1348	1	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1348	1433	45	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1433	1445	12	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOAD DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1445	1620	95	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/3/2003	2	OPEN FIELD	1620	1650	30	SET-UP/DAILY START/STOP/CALIBRATION	END OF DAILY OPERATIONS/EQUIPMENT BREAKDOWN	GPS	NA	LINEAR	SUNNY	MUDDY
5/5/2003	2	OPEN FIELD	805	945	100	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/5/2003	2	OPEN FIELD	945	1106	81	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/5/2003	2	OPEN FIELD	1106	1121	15	BREAK/LUNCH	BREAK/LUNCH	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/5/2003	2	OPEN FIELD	1121	1145	24	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/5/2003	2	OPEN FIELD	1145	1156	11	WEATHER ISSUE	RAIN	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/5/2003	2	OPEN FIELD	1156	1209	13	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/5/2003	2	OPEN FIELD	1209	1231	22	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOAD DATA	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/5/2003	2	OPEN FIELD	1231	1258	27	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/5/2003	2	OPEN FIELD	1258	1303	65	WEATHER ISSUE	RAIN	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/5/2003	2	OPEN FIELD	1303	1410	67	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/5/2003	2	OPEN FIELD	1410	1428	18	BREAK/LUNCH	BREAK/LUNCH	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/5/2003	2	OPEN FIELD	1428	1550	82	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/5/2003	2	OPEN FIELD	1550	1621	31	SET-UP/DAILY START/STOP/CALIBRATION	END OF DAILY OPERATIONS/EQUIPMENT BREAKDOWN	GPS	NA	LINEAR	CLOUDY	MUDDY, RAIN
5/6/2003	2	OPEN FIELD	738	925	107	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION	GPS	NA	LINEAR	SUNNY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status - Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
5/6/2003	2	OPEN FIELD	925	1035	70	EQUIPMENT FAILURE	BAD CABLE CONNECTION, SODERED CABLE	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	2	OPEN FIELD	1035	1204	89	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	2	OPEN FIELD	1204	1240	36	BREAK/LUNCH	BREAK/LUNCH	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	1	OPEN FIELD	1240	1422	102	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	1	OPEN FIELD	1422	1450	28	BREAK/LUNCH	BREAK/LUNCH	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	1	OPEN FIELD	1450	1619	89	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	1	OPEN FIELD	1619	1635	16	DOWNTIME DUE TO EQUIP MAIN/CHECK	DOWNLOAD DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	1	OPEN FIELD	1635	1710	35	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	2	OPEN FIELD	1710	1844	94	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/6/2003	2	OPEN FIELD	1844	1918	34	SET-UP/DAILY START/STOP/CALIBRATION	END OF DAILY OPERATIONS/EQUIPMENT BREAKDOWN	GPS	NA	LINEAR	SUNNY	MUDDY
							SLED WAS BROKEN WHILE PUTTING IT AWAY FOR THE EVENING	GPS	NA	LINEAR		
5/7/2003	2	OPEN FIELD	800	900	60	SET-UP/DAILY START/STOP/CALIBRATION	SET UP/MOBILIZATION, PUTTING SLED TOGETHER	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	1	OPEN FIELD	900	929	29	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	1	OPEN FIELD	929	931	2	BREAK/LUNCH	BREAK/LUNCH	GPS	NA	LINEAR	SUNNY	MUDDY
5/7/2003	1	OPEN FIELD	931	1041	70	COLLECT DATA	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

APPENDIX E. REFERENCES

1. Standardized UXO Technology Demonstration Site Handbook, DTC Project No. 8-CO-160-000-473, Report No. ATC-8349, March 2002.

2. Aberdeen Proving Ground Soil Survey Report, October 1998.

3. Data Summary, UXO Standardized Test Site: APG Soils Description, May 2002.

4. Practical Nonparametric Statistics, W.J. Conover, John Wiley & Sons, 1980, pages 144 through 151.

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APPENDIX F. ABBREVIATIONS

A/D	=	analog/digital
AEC	=	U.S. Army Environmental Center
APG	=	Aberdeen Proving Ground
ATC	=	U.S. Army Aberdeen Test Center
ATV	=	all terrain vehicle
DFT	=	Digital Fourier Transform
DGPS	=	digital Global Positioning System
DSP	=	digital signal processor
EMI	=	electromagnetic induction
ERDC	=	U.S. Army Corp of Engineers Engineering, Research and Development Center
ESTCP	=	Environmental Security Technology Certification Program
EQT	=	Army Environmental Quality Technology Program
GPS	=	Global Positioning System
JPG	=	Jefferson Proving Ground
POC	=	point of contact
QA	=	quality assurance
QC	=	quality control
RAM	=	random access memory
ROC	=	receiver-operating characteristic
SERDP	=	Strategic Environmental Research and Development Program
UXO	=	unexploded ordnance
YPG	=	U.S. Army Yuma Proving Ground

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